

AD-A169 190

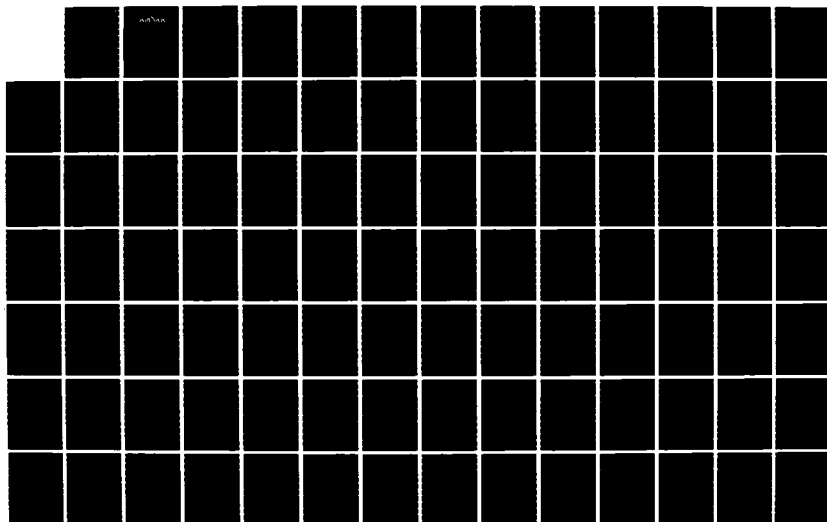
A MULTIPLE-BURST VEHICLE KILL PROBABILITY MODEL WHERE
THE PROBABILITY OF..(U) ARMY MATERIEL SYSTEMS ANALYSIS
ACTIVITY ABERDEEN PROVING GROU.. A D GROVES FEB 86
AMSAA-TR-418

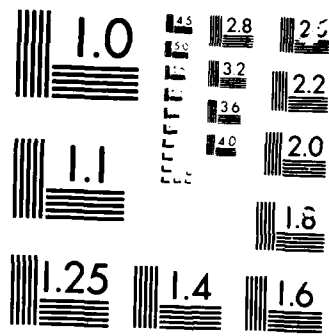
1/1

UNCLASSIFIED

F/O 15/7

NL



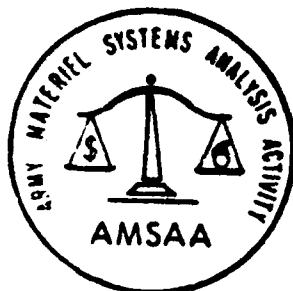


MICROCOPY

201111

12

AD



AMSAA

TECHNICAL REPORT NO. 418

A MULTIPLE-BURST VEHICLE KILL PROBABILITY MODEL,
WHERE THE PROBABILITY OF IGNITING SPILLED FLAMMABLE FLUIDS IS TIME DEPENDENT

ARTHUR D. GROVES

FEBRUARY 1986

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

DTIC
ELECTE
JUN 26 1986

PS

E

D

U. S. ARMY MATERIEL SYSTEMS ANALYSIS ACTIVITY
ABERDEEN PROVING GROUND, MARYLAND

86 6 26 004

AD-A169 190

DTIC FILE COPY

DISPOSITION

Destroy this report when no longer needed. Do not return it to the originator.

DISCLAIMER

The findings in this report are not to be construed as an official Department of the Army position unless so specified by other official documentation.

WARNING

Information and data contained in this document are based on the input available at the time of preparation. The results may be subject to change and should not be construed as representing the DARCOM position unless so specified.

TRADE NAMES

The use of trade names in this report does not constitute an official endorsement or approval of the use of such commercial hardware or software. The report may not be cited for purposes of advertisement.

UNCLASSIFIED

12

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM	
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER	
Technical Report No. 418	A16990		
4. TITLE (and Subtitle)		5. TYPE OF REPORT & PERIOD COVERED	
A Multiple-Burst Vehicle Kill Probability Model, Where the Probability of Igniting Spilled Flammable Fluids Is Time Dependent		Final	
7. AUTHOR(s)		6. PERFORMING ORG. REPORT NUMBER	
Arthur D. Groves			
9. PERFORMING ORGANIZATION NAME AND ADDRESS		8. CONTRACT OR GRANT NUMBER(s)	
US Army Materiel Systems Analysis Activity Aberdeen Proving Ground, Maryland 21005-5071			
11. CONTROLLING OFFICE NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS	
US Army Materiel Command 5001 Eisenhower Avenue Alexandria, VA 22333-0001			
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE	
		February 1986	
		13. NUMBER OF PAGES	
		100	
		15. SECURITY CLASS. (of this report)	
		UNCLASSIFIED	
		15a. DECLASSIFICATION DOWNGRADING SCHEDULE	
16. DISTRIBUTION STATEMENT (of this Report)			
Distribution Unlimited/Approved For Public Release			
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)			
18. SUPPLEMENTARY NOTES			
19. KEY WORDS (Continue on reverse side if necessary and identify by block number)			
Multiple Burst Vehicle Kill Probability Model Effect of Flammable Fluids			
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)			
This report presents a multiple-burst vehicle kill probability model. The methodology developed includes as kill mechanisms mechanical damage, ignition of flammable fluids from the puncture of reservoirs and lines by high energy projectiles, ignition of fluids which were spilled but not ignited on earlier rounds, and the ignition or detonation of stowed ammunition. The methodology is valid for any number of bursts, but the FORTRAN program included in the report is limited in applicability to at most three bursts.			

DD FORM 1 JAN 73 1473

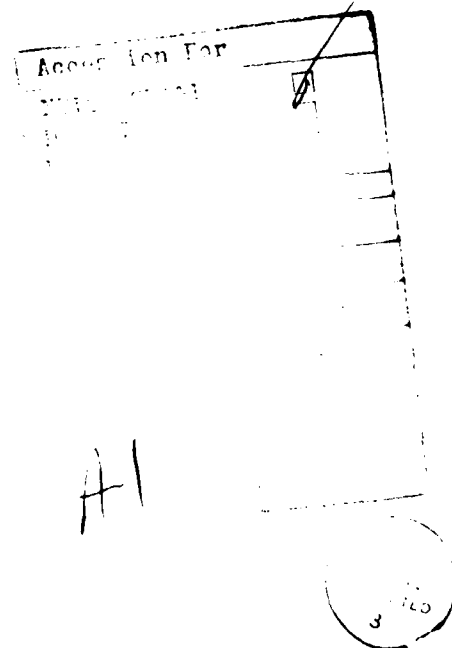
EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

ACKNOWLEDGEMENT

The US Army Materiel Systems Analysis Activity (AMSAA) recognizes the following individual for contributing to this report.

Peer Reviewer: Bernie Goulet, Ground Warfare Division (GWD)



The next page is blank.

CONTENTS

	<u>Page</u>
ACKNOWLEDGEMENTS	iii
LIST OF TABLES	vi
1. INTRODUCTION	1
2. DERIVATION	2
3. NUMERICAL EXAMPLE.	12
REFERENCE.	30
APPENDIX	31
DISTRIBUTION LIST.	91

LIST OF TABLES

<u>Table No.</u>		<u>Page</u>
1	Transition Probabilities from S_0 to S_1 Mutually Exclusive Events.	9
2	Transition Probabilities from S_0 to S_1 Independent Events .	10
3	Transition Probabilities from S_{i-1} to S_i Mutually Exclusive Events.	12
4	Transition Probabilities from S_{i-1} to S_i Independent Events	13
5	Recursive Formulas Mutually Exclusive Events	15
6	Recursive Formulas Independent Events	16
7	Damage Categories and Their Probabilities of Occurrence After i Bursts	18
8	Input File for Numerical Example	23
9	First Output Page - Numerical Example	24
10	Second Output Page - Numerical Example	25
11	Third Output Page - Numerical Example	26
12	Fourth Output Page - Numerical Example	27
13	Fifth Output Page - Numerical Example	28

A Multiple-Burst Vehicle Kill Probability Model,
Where the Probability of Igniting
Spilled Flammable Fluids is Time Dependent

1. INTRODUCTION

Military vehicles form a very important class of targets against which kill probabilities must be computed for various weapons. There are generally two types of damage which can result in a kill of a vehicle. These are (1) a specified type of mechanical damage, and (2) fire. A fire can generally be started either as the instantaneous result of puncturing some component containing flammable fluid with a high energy projectile, or by igniting such fluid which was spilled but not ignited by earlier punctures. Since the amount, and perhaps the location, of the spilled fluid would generally depend on the number and times of occurrence of previous punctures, the probability of igniting such spilled fluid might also depend on these factors. An earlier report (Reference 1) developed a kill probability model including consideration of this dependence. In that report it was assumed that there was only one kind of flammable fluid in the vehicle (fuel), and it was all in a single location. In this report there can be a number of different kinds of flammable fluids, a number of different fluid locations, and up to two "sinks" into which spilled fluid collects. A third cause of fire treated in this report but not in the earlier one is the detonation or ignition of stored ammunition if it is struck by a projectile. The formulas in this report, then, include those of the earlier report as special cases, and the earlier report can be considered obsolete and superceded by this one.

The model to be presented is not a vehicle vulnerability model, but merely describes a method for putting together certain basic vulnerability-related probabilities to obtain the overall probability that the vehicle is killed. The basic probabilities, which are related to various aspects of vehicle vulnerability, are assumed to be available from standard vehicle vulnerability and fluid ignition models, and are not generated in the present model.

There are four basic damage events that may occur when a burst of rounds is fired at a vehicle. These are (1) the vehicle may receive disabling mechanical damage, (2) some component containing flammable fluid may be punctured, with with an associated spillage of that fluid, possibly causing an immediate fire, (3) stowed ammunition may be struck by a projectile, possible causing an immediate fire, and (4) flammable fluid which was spilled but not ignited by earlier bursts may be ignited by the burst under consideration.

Two conditions of dependence among these basic events are treated in this report. The first is that of complete independence among the events, whereby the probability of occurrence of any one of them on a given burst does not depend on whether any of the others have occurred on that burst. This case might be appropriate for the situation where the number of rounds in the burst is large. The second condition is that of complete dependence among the events, whereby the occurrence of any one of them precludes the occurrence of any of the others on the same burst. This case might be appropriate when consecutive single rounds are fired at the vehicle, that is, when each burst consists of only a single round.

2. DERIVATION

Let t_i be the time at which the rounds from the i^{th} burst arrive at the target vehicle. It is assumed that all the rounds of a given burst arrive at the vehicle at the same time, but the time varies from burst to burst. This is not a restrictive assumption, because a burst that extends over a significant interval in time can be subdivided into shorter bursts, even to single-round bursts, if desired, with each shorter burst assumed to have all its rounds arrive at the same time.

The condition of the vehicle at any time can be expressed using the following vector-like notation:

$$v = (F, G, g),$$

where F describes the condition of the vehicle relative to the puncture of components containing flammable fluids which will drain into the first sink, G describes the condition of the vehicle relative to the puncture of components

containing flammable fluids which will drain into the second sink, and g describes the condition of the vehicle relative to disabling mechanical damage. Specifically, if the vehicle is not on fire, F is the set of times at which punctures of the fluid locations have occurred which cause fluid to drain into the first sink, and G is the set of times at which punctures of the fluid locations have occurred which cause fluid to drain into the second sink. If no punctures have occurred, the symbol \emptyset (the empty set) will be used for either F or G . If the vehicle has suffered disabling mechanical damage, $g = 1$; if not, $g = 0$. If the vehicle is on fire, the special vector $(*,g)$ will be used. Therefore, using this notation, a completely undamaged vehicle would be denoted by the vector $(\emptyset, \emptyset, 0)$.

Before any computations can be made, several basic probability tables or functions must be provided. These relate to the vulnerability of the vehicle, the characteristics of the ammunition being fired at the vehicle, the delivery accuracy of the weapon, and the number of rounds in a burst.

$P_9^i(j)$ = probability that a puncture of the j^{th} flammable fluid location occurs on the i^{th} burst.

$P_{10}^i(j)$ = conditional probability that the i^{th} burst causes a fluid fire, given that it has punctured the j^{th} fluid location. This type of fire will be referred to as a Type I fire, and is distinguished from one caused by a burst igniting fluid which was spilled but not ignited by rounds of a previous burst.

$P_{11}^i(k)$ = probability of perforating the k^{th} sink on the i^{th} burst.

$P_{12}^i(1,F)$ = conditional probability that the i^{th} burst ignites fluid that was spilled into sink 1 by the previous punctures identified in the set F , given that sink 1 was perforated on the i^{th} burst.

$P_{12}^i(2,G)$ = conditional probability that the i^{th} burst ignites fluid that was spilled into sink 2 by the previous punctures identified in the set G, given that sink 2 was perforated on the i^{th} burst.

A fire resulting from the ignition of previously-spilled fluids is called a Type II fire.

Since there are many possible compositions of the sets F and G for each i, there will be as many values of $P_{12}^i(1,F)$ and $P_{12}^i(2,G)$. Since F and G are subsets of the times

$$t_1, t_2, \dots, t_{i-1},$$

and there are 2^{i-1} possible subsets, there are 2^{i-1} possible F's and 2^{i-1} possible G's. For example, if $i = 4$, there are eight possible F's and eight possible G's. These are:

\emptyset	t_1	$t_1 t_2$	$t_1 t_2 t_3$
	t_2	$t_1 t_3$	
	t_3	$t_2 t_3$	

P_4^i = probability that the i^{th} burst causes disabling mechanical damage.

F_b^i = probability that stowed ammunition is detonated or ignited, causing a fire, on the i^{th} burst.

There are several other probabilities derived from those listed above that are required. The first is the probability of puncturing one or more of the flammable fluid locations that drain into each sink. If $P_1^i(k)$ denotes this probability for sink k, then

$$P_1^i(k) = \sum_{j \text{ in } K_k} P_9^i(j) \quad (\text{Dependent Events})$$

or

$$P_1^i(k) = 1 - \prod_{j \text{ in } K_k} [1 - P_9^i(j)] \quad (\text{Independent Events})$$

where K_k denotes the set of fluid locations which drain into sink k . The second of these derived probabilities is the probability of causing a Type I fire in one or more of the flammable fluid locations that drain into each sink. If $P_5^i(k)$ denotes this probability for sink k , then

$$P_5^i(k) = \sum_{j \text{ in } K_k} P_9^i(j) P_{10}^i(j) \quad (\text{Dependent Events})$$

or

$$P_5^i(k) = 1 - \prod_{j \text{ in } K_k} [1 - P_9^i(j) P_{10}^i(j)] \quad (\text{Independent Events})$$

In either the Dependent Event case or the Independent Event case, the probability that fluids are spilled into sink k without causing a Type I fire, denoted $P_8^i(k)$, is given by

$$P_8^i(k) = P_1^i(k) - P_5^i(k)$$

The final probability derived from those shown above is the probability of a Type II fire, that is, the probability that one or both sinks are perforated and the fluids spilled into those sinks on the set of previous bursts identified by the sets F and G are ignited. If $P_7^i(F,G)$ denotes this

probability, then

$$P_7^i(F,G) = P_{11}^i(1) P_{12}^i(1,F) + P_{11}^i(2) P_{12}^i(2,G) \quad (\text{Dependent Events})$$

or

$$P_7^i(F,G) = 1 - [1 - P_{11}^i(1) P_{12}^i(1,F)][1 - P_{11}^i(2) P_{12}^i(2,G)] \quad (\text{Independent Events})$$

For any of these probabilities, Q , with the same subscripts, superscripts and arguments, will be used to represent $1 - P$. For example,

$$Q_4^i = 1 - P_4^i.$$

In addition, note that if $F = \emptyset$ or $G = \emptyset$, that is, if there have been no punctures prior to time t_i , then the corresponding $P_{12}^i = 0$.

Now let S_i denote the set of possible vectors (vehicle states) after the i^{th} burst. For $i = 0$, that is, before the first burst, S_0 consists of the single state $(\emptyset, \emptyset, 0)$. After the first burst, which occurs at time t_1 , ten states are possible, so S_1 consists of ten vectors. These are:

- $(\emptyset, \emptyset, 0)$ which occurs if the first burst does no damage,
- $(t_1, \emptyset, 0)$ which occurs if the first burst punctures one or more flammable fluid locations which drain into the first sink without causing a Type I fire, does not puncture any of the fluid locations which drain into the second sink, does not cause disabling mechanical damage, and does not cause an ammunition fire,
- $(\emptyset, t_1, 0)$ which occurs if the first burst punctures one or more flammable fluid locations which drain into the second sink without causing a Type I fire, does not puncture any of the fluid locations which drain into the first sink, does not cause disabling mechanical damage, and does not cause an ammunition fire,

- $(t_1, t_1, 0)$ which occurs if the first burst punctures one or more flammable fluid locations which drain into the first sink without causing a Type I fire, punctures one or more flammable fluid locations which drain into the second sink without causing a Type I fire, does not cause disabling mechanical damage, and does not cause an ammunition fire,
- $(*; 0)$ which occurs if the first burst does not cause disabling mechanical damage, but causes either a Type I fuel fire or an ammunition fire,
- $(\emptyset, \emptyset, 1)$ which occurs if the first burst causes disabling mechanical damage only,
- $(t_1, \emptyset, 1)$ which occurs if the first burst punctures one or more flammable fluid locations which drain into the first sink without causing a Type I fire, does not puncture any of the fluid locations which drain into the second sink, causes disabling mechanical damage, and does not cause an ammunition fire,
- $(\emptyset, t_1, 1)$ which occurs if the first burst punctures one or more flammable fluid locations which drain into the second sink without causing a Type I fire, does not puncture any of the fluid locations which drain into the first sink, causes disabling mechanical damage, and does not cause an ammunition fire,
- $(t_1, t_1, 1)$ which occurs if the first burst punctures one or more flammable fluid locations which drain into the first sink without causing a Type I fire, punctures one or more flammable fluid locations which drain into the second sink without causing a Type I fire, causes disabling mechanical damage, and does not cause an ammunition fire, and finally,

(*; 1) which occurs if the first burst causes disabling mechanical damage, and also causes either a Type 1 fuel fire or an ammunition fire.

Note that if the basic damage events are completely dependent, so that the burst can cause at most one of the events, vectors $(t_1, t_1, 0)$, $(t_1, \emptyset, 1)$, $(\emptyset, t_1, 1)$, $(t_1, t_1, 1)$, and $(*; 1)$ cannot occur in S_1 . The probabilities for the transition from S_0 to S_1 are shown in Table 1 for the case of Dependent Events, and in Table 2 for the case of Independent Events.

On the second burst, similar tables of transitions from the vectors in S_1 to vectors in S_2 , with the associated probabilities, could be made. These would show that S_2 consists of 34 different vectors. These are:

$(\emptyset, \emptyset, g)$	(\emptyset, t_1, g)	(\emptyset, t_2, g)	$(\emptyset, t_1 t_2, g)$
(t_1, \emptyset, g)	(t_1, t_1, g)	(t_1, t_2, g)	$(t_1, t_1 t_2, g)$
(t_2, \emptyset, g)	(t_2, t_1, g)	(t_2, t_2, g)	$(t_2, t_1 t_2, g)$
$(t_1 t_2, \emptyset, g)$	$(t_1 t_2, t_1, g)$	$(t_1 t_2, t_2, g)$	$(t_1 t_2, t_1 t_2, g)$

and $(*, g)$, where $g = 0$ and $g = 1$.

On the third burst, similar tables of transitions from the vectors in S_2 to vectors in S_3 would show a total of 130 different vectors. These are:

$(\emptyset, \emptyset, g)$	(\emptyset, t_1, g)	(\emptyset, t_2, g)	(\emptyset, t_3, g)
(t_1, \emptyset, g)	(t_1, t_1, g)	(t_1, t_2, g)	(t_1, t_3, g)
(t_2, \emptyset, g)	(t_2, t_1, g)	(t_2, t_2, g)	(t_2, t_3, g)
(t_3, \emptyset, g)	(t_3, t_1, g)	(t_3, t_2, g)	(t_3, t_3, g)
$(t_1 t_2, \emptyset, g)$	$(t_1 t_2, t_1, g)$	$(t_1 t_2, t_2, g)$	$(t_1 t_2, t_3, g)$
$(t_1 t_3, \emptyset, g)$	$(t_1 t_3, t_1, g)$	$(t_1 t_3, t_2, g)$	$(t_1 t_3, t_3, g)$
$(t_2 t_3, \emptyset, g)$	$(t_2 t_3, t_1, g)$	$(t_2 t_3, t_2, g)$	$(t_2 t_3, t_3, g)$
$(t_1 t_2 t_3, \emptyset, g)$	$(t_1 t_2 t_3, t_1, g)$	$(t_1 t_2 t_3, t_2, g)$	$(t_1 t_2 t_3, t_3, g)$

Table 1
Transition Probabilities from S_0 to S_1
Dependent Events

Vector in S_0	Vector in S_1	Probability
$(\emptyset, \emptyset, 0)$	$(\emptyset, \emptyset, 0)$	$1 - P_1^1(1) - P_1^1(2) - P_4^1 - P_6^1$
	$(\emptyset, \tau_1, 0)$	$P_8^1(2)$
	$(\tau_1, \emptyset, 0)$	$P_8^1(1)$
	$(\tau_1, \tau_1, 0)$	0
	$(*, 0)$	$P_5^1(1) + P_5^1(2) + P_6^1$
	$(\emptyset, \emptyset, 1)$	P_4^1
	$(\emptyset, \tau_1, 1)$	0
	$(\tau_1, \emptyset, 1)$	0
	$(\tau_1, \tau_1, 1)$	0
	$(*, 1)$	0

Table 2
Transition Probabilities from S_0 to S_1
Independent Events

Vector in S_0	Vector in S_1	Probability
$(\emptyset, \emptyset, 0)$	$(\emptyset, \emptyset, 0)$	$Q_1^1(1) Q_1^1(2) Q_4^1 Q_6^1$
	$(\emptyset, \tau_1, 0)$	$Q_1^1(1) P_8^1(2) Q_4^1 Q_6^1$
	$(\tau_1, \emptyset, 0)$	$P_8^1(1) Q_1^1(2) Q_4^1 Q_6^1$
	$(\tau_1, \tau_1, 0)$	$P_8^1(1) P_8^1(2) Q_4^1 Q_6^1$
	$(*, 0)$	$Q_4^1 [1 - Q_5^1(1) Q_5^1(2) Q_6^1]$
	$(\emptyset, \emptyset, 1)$	$Q_1^1(1) Q_1^1(2) P_4^1 Q_6^1$
	$(\emptyset, \tau_1, 1)$	$P_8^1(2) Q_1^1(1) P_4^1 Q_6^1$
	$(\tau_1, \emptyset, 1)$	$P_8^1(1) Q_1^1(2) P_4^1 Q_6^1$
	$(\tau_1, \tau_1, 1)$	$P_8^1(1) P_8^1(2) P_4^1 Q_6^1$
	$(*, 1)$	$P_4^1 [1 - Q_5^1(1) Q_5^1(2) Q_6^1]$

$(\emptyset, t_1 t_2, g)$	$(\emptyset, t_1 t_3, g)$	$(\emptyset, t_2 t_3, g)$	$(\emptyset, t_1 t_2 t_3, g)$
$(t_1, t_1 t_2, g)$	$(t_1, t_1 t_3, g)$	$(t_1, t_2 t_3, g)$	$(t_1, t_1 t_2 t_3, g)$
$(t_2, t_1 t_2, g)$	$(t_2, t_1 t_3, g)$	$(t_2, t_2 t_3, g)$	$(t_2, t_1 t_2 t_3, g)$
$(t_3, t_1 t_2, g)$	$(t_3, t_1 t_3, g)$	$(t_3, t_2 t_3, g)$	$(t_3, t_1 t_2 t_3, g)$
$(t_1 t_2, t_1 t_2, g)$	$(t_1 t_2, t_1 t_3, g)$	$(t_1 t_2, t_2 t_3, g)$	$(t_1 t_2, t_1 t_2 t_3, g)$
$(t_1 t_3, t_1 t_2, g)$	$(t_1 t_3, t_1 t_3, g)$	$(t_1 t_3, t_2 t_3, g)$	$(t_1 t_3, t_1 t_2 t_3, g)$
$(t_2 t_3, t_1 t_2, g)$	$(t_2 t_3, t_1 t_3, g)$	$(t_2 t_3, t_2 t_3, g)$	$(t_2 t_3, t_1 t_2 t_3, g)$
$(t_1 t_2 t_3, t_1 t_2, g)$	$(t_1 t_2 t_3, t_1 t_3, g)$	$(t_1 t_2 t_3, t_2 t_3, g)$	$(t_1 t_2 t_3, t_1 t_2 t_3, g)$

and $(*, g)$, where $g = 0$ and $g = 1$.

The pattern should now be apparent. In general, the set S_i consists of $2(2^{2i} + 1)$ vectors, divided into two sets of $2^{2i} + 1$ vectors each. The first set has $g = 0$ and the second set has $g = 1$. Each of these sets consists of a single vector $(*, g)$ and 2^i groups of 2^i vectors each corresponding to the numbers of possible combinations of the times

$$t_1, t_2, t_3 \dots t_i.$$

Before generalizing the probabilities for the transition from set S_{i-1} to set S_i , the notation to be used will be described. L_i will denote the set of times $[t_1, t_2, t_3, \dots, t_i]$. Then L_{i-1} is the set $[t_1, t_2, t_3, \dots, t_{i-1}]$ of times prior to t_i . F and G will denote subsets of L_{i-1} or L_i . If F and G are subsets of L_{i-1} , then $F + t_i$ and $G + t_i$ will denote the sets consisting of the elements of F and the time t_i , or the elements of G and the time t_i . Thus, for example, if $F = [t_1, t_2, t_4]$, then $F + t_6 = [t_1, t_2, t_4, t_6]$. Similarly, if $G = \emptyset$, then $G + t_6 = [t_6]$. The notation " F in L_i " will signify "for all subsets F of L_i ." Similarly, the notation " G in L_i " will signify "for all subsets G of L_i ." With this notation the transition probabilities, and later, the recursive formulas, can be very concisely presented. Tables 3 and 4 show the generalized probabilities of transition from S_{i-1} to S_i for the Dependent-Events case and the Independent-Events case respectively. (Recall that $P_{12}^i(k, \emptyset) = 0$ for all i .)

Table 3
 Transition Probabilities from S_{i-1} to S_i
 Dependent Damage Events
 (for F, G in L_{i-1})

Vector in S_{i-1}	Vector in S_i	Probability
(F,G,0)	(F,G,0)	$1 - P_1^i(1) - P_1^i(2) - P_7^i(F,G) - P_4^i - P_6^i$
	(F+t _i ,G,0)	$P_8^i(1)$
	(F,G+t _i ,0)	$P_8^i(2)$
	(*,0)	$P_5^i(1) + P_5^i(2) + P_7^i(F,G) + P_6^i$
	(F,G,1)	P_4^i
(*,0)	(*,0)	Q_4^i
	(*,1)	P_4^i
(F,G,1)	(F,G,1)	$1 - P_1^i(1) - P_1^i(2) - P_7^i(F,G) - P_6^i$
	(F+t _i ,G,1)	$P_8^i(1)$
	(F,G+t _i ,1)	$P_8^i(2)$
	(*,1)	$P_5^i(1) + P_5^i(2) + P_7^i(F,G) + P_6^i$
(*,1)	(*,1)	1

Table 4
 Transition Probabilities from S_{i-1} to S_i
 Independent Damage Events
 (For F, G in L_{i-1})

Vector in S_{i-1}	Vector in S_i	Probability
(F,G,0)	(F,G,0)	$Q_1^i(1) Q_1^i(2) Q_7^i(F,G) Q_4^i Q_6^i$
	$(F+t_i, G, 0)$	$P_8^i(1) Q_1^i(2) Q_7^i(F,G) Q_4^i Q_6^i$
	$(F, G+t_i, 0)$	$Q_1^i(1) P_8^i(2) Q_7^i(F,G) Q_4^i Q_6^i$
	$(F+t_i, G+t_i, 0)$	$P_8^i(1) P_8^i(2) Q_7^i(F,G) Q_4^i Q_6^i$
	(*,0)	$Q_4^i [1-Q_5^i(1) Q_5^i(2) Q_7^i(F,G) Q_6^i]$
	(F,G,1)	$Q_1^i(1) Q_1^i(2) Q_7^i(F,G) P_4^i Q_6^i$
	$(F+t_i, G, 1)$	$P_8^i(1) Q_1^i(2) Q_7^i(F,G) P_4^i Q_6^i$
	$(F, G+t_i, 1)$	$Q_1^i(1) P_8^i(2) Q_7^i(F,G) P_4^i Q_6^i$
	$(F+t_i, G+t_i, 1)$	$P_8^i(1) P_8^i(2) Q_7^i(F,G) P_4^i Q_6^i$
	(*,1)	$P_4^i [1-Q_5^i(1) Q_5^i(2) Q_7^i(F,G) Q_6^i]$
(*,0)		Q_4^i
(*,1)		P_4^i
(F,G,1)	(F,G,1)	$Q_1^i(1) Q_1^i(2) Q_7^i(F,G) Q_6^i$
	$(F+t_i, G, 1)$	$P_8^i(1) Q_1^i(2) Q_7^i(F,G) Q_6^i$
	$(F, G+t_i, 1)$	$Q_1^i(1) P_8^i(2) Q_7^i(F,G) Q_6^i$
	$(F+t_i, G+t_i, 1)$	$P_8^i(1) P_8^i(2) Q_7^i(F,G) Q_6^i$
	(*,1)	$1-Q_5^i(1) Q_5^i(2) Q_7^i(F,G) Q_6^i$
(*,1)	(*,1)	1

The probabilities in Tables 3 and 4 will be used to develop sets of recursive formulas for determining the probabilities of occurrence of the various vectors of S_i , given the probabilities for the vectors of S_{i-1} . First, we introduce the notation $P_i(F, G, g)$ to denote the probability of occurrence of the vector (F, G, g) in the set S_i . To illustrate how the recursive formulas are developed, consider the determination of $P_i(\emptyset, \emptyset, 1)$. Table 3 and Table 4 show that the vector $(\emptyset, \emptyset, 1)$ in S_i can result from either one of two possible transitions from vectors in S_{i-1} . These are:

- (1) $(\emptyset, \emptyset, 0)$ in S_{i-1} , with only disabling mechanical damage occurring on the i^{th} burst, or
- (2) $(\emptyset, \emptyset, 1)$ in S_{i-1} , with no puncture or the fluid system and no ammunition fire occurring on the i^{th} burst.

Therefore, the probability of occurrence of $(\emptyset, \emptyset, 1)$ in S_i is the sum of two probabilities. These are:

- (1) the product of the probability of occurrence of $(\emptyset, \emptyset, 0)$ in S_{i-1} and the probability of transition from $(\emptyset, \emptyset, 0)$ in S_{i-1} to $(\emptyset, \emptyset, 1)$ in S_i , and
- (2) the product of the probability of occurrence of $(\emptyset, \emptyset, 1)$ in S_{i-1} and the probability that $(\emptyset, \emptyset, 1)$ remains unchanged by the i^{th} burst.

Thus, for the case of independent damage events,

$$P_i(\emptyset, \emptyset, 1) = Q_1^i(1) Q_1^i(2) Q_0^i [P_{i-1}(\emptyset, \emptyset, 0) P_4^i + P_{i-1}(\emptyset, \emptyset, 1)]$$

This same reasoning has been applied to all vectors to obtain the complete set of recursive formulas shown in Tables 5 and 6. To use these tables to obtain the probabilities of occurrence of the various vectors in S_i , for any i , it only remains to specify starting values $P_0(F, G, g)$ for the possible vectors in S_0 . But S_0 consists of only the single vector $(\emptyset, \emptyset, 0)$. Thus $P_0(\emptyset, \emptyset, 0) = 1$

Table 5
Recursive Formulas
Dependent Damage Events
(For F, G in L_{i-1})

1. $P_i(F, G, 0) = P_{i-1}(F, G, 0) [1 - P_1^i(1) - P_1^i(2) - P_7^i(F, G) - P_4^i - P_6^i]$
2. $P_i(F+t_i, G, 0) = P_{i-1}(F, G, 0) P_8^i(1)$
3. $P_i(F, G+t_i, 0) = P_{i-1}(F, G, 0) P_8^i(2)$
4. $P_i(*, 0) = P_{i-1}(*, 0) Q_4^i + P_{i-1}(F, G, 0) [P_5^i(1) + P_5^i(2) + P_7^i(F, G) + P_6^i]$
 $F, G \text{ in } L_{i-1}$
5. $P_i(F, G, 1) = P_{i-1}(F, G, 0) P_4^i + P_{i-1}(F, G, 1) [1 - P_1^i(1) - P_1^i(2) - P_7^i(F, G) - P_6^i]$
6. $P_i(F+t_i, G, 1) = P_{i-1}(F, G, 1) P_8^i(1)$
7. $P_i(F, G+t_i, 1) = P_{i-1}(F, G, 1) P_8^i(2)$
8. $P_i(*, 1) = P_{i-1}(*, 0) P_4^i + P_{i-1}(*, 1)$
 $+ P_{i-1}(F, G, 1) [P_5^i(1) + P_5^i(2) + P_7^i(F, G) + P_6^i]$
 $F, G \text{ in } L_{i-1}$

Table 6
Recursive Formulas
Independent Damage Events
(For F, G in L_{i-1})

$$1. P_i(F, G, 0) = P_{i-1}(F, G, 0) Q_1^i(1) Q_1^i(2) Q_7^i(F, G) Q_4^i Q_6^i$$

$$2. P_i(F+t_i, G, 0) = P_{i-1}(F, G, 0) P_8^i(1) Q_1^i(2) Q_7^i(F, G) Q_4^i Q_6^i$$

$$3. P_i(F, G+t_i, 0) = P_{i-1}(F, G, 0) P_8^i(2) Q_1^i(1) Q_7^i(F, G) Q_4^i Q_6^i$$

$$4. P_i(F+t_i, G+t_i, 0) = P_{i-1}(F, G, 0) P_8^i(1) P_8^i(2) Q_7^i(F, G) Q_4^i Q_6^i$$

$$5. P_i(*, 0) = Q_4^i P_{i-1}(*, 0) + P_{i-1}(F, G, 0) [1 - Q_5^i(1) Q_5^i(2) Q_7^i(F, G) Q_6^i]$$

$F, G \text{ in } L_{i-1}$

$$6. P_i(F, G, 1) = Q_1^i(1) Q_1^i(2) Q_7^i(F, G) Q_6^i [P_{i-1}(F, G, 0) P_4^i + P_{i-1}(F, G, 1)]$$

$$7. P_i(F+t_i, G, 1) = P_8^i(1) Q_1^i(2) Q_7^i(F, G) Q_6^i [P_{i-1}(F, G, 0) P_4^i + P_{i-1}(F, G, 1)]$$

$$8. P_i(F, G+t_i, 1) = P_8^i(2) Q_1^i(1) Q_7^i(F, G) Q_6^i [P_{i-1}(F, G, 0) P_4^i + P_{i-1}(F, G, 1)]$$

$$9. P_i(F+t_i, G+t_i, 1) = P_8^i(1) P_8^i(2) Q_7^i(F, G) Q_6^i [P_{i-1}(F, G, 0) P_4^i + P_{i-1}(F, G, 1)]$$

$$10. P_i(*, 1) = P_{i-1}(*, 0) P_4^i + P_{i-1}(*, 1)$$

$$+ [P_{i-1}(F, G, 0) P_4^i + P_{i-1}(F, G, 1)] [1 - Q_5^i(1) Q_5^i(2) Q_7^i(F, G) Q_6^i]$$

$F, G \text{ in } L_{i-1}$

and $P_0(F,G,g) = 0$ for all other (F,G,g) .

The $2(2^{2i} + 1)$ states whose probabilities of occurrence are generated from Tables 5 and 6 are generally not of individual tactical interest. For example, if a vehicle is afire after a certain number of bursts have been fired at it, it is probably of no tactical interest whether or not the vehicle has also suffered disabling mechanical damage. Table 7 shows a list of nine damage categories that might be of tactical interest, the list of vectors that correspond to each of these categories, and the probabilities of occurrence of each of these categories in terms of the recursively defined probabilities in Tables 5 or 6. Note that the probability of occurrence of any damage category is simply the sum of the probabilities of occurrence of the vectors (states) that comprise that category.

The damage categories identified in Table 7 can easily be related to the vehicle kill categories familiar to army vulnerability analysts. They speak of "M or F" kill, meaning the loss of either mobility or firepower, and "K" kill, meaning the catastrophic loss of the vehicle. A "K" kill occurs only as a result of an uncontrolled fire. An "M or F" kill is assessed whenever certain selected components are subjected to specific levels of mechanical damage, and is also assessed whenever a "K" kill is assessed. Therefore the category "Fire" in Table 7 can be equated to "K" kill as long as the kind of fire represented by the input values of P_{10} and P_{12} is the same kind of uncontrolled fire that will cause a "K" kill. Similarly if the mechanical damage whose probability of occurrence is input as P_4 is that which causes an "M or F" kill, and a puncture or any fluid system also leads to such a kill, then categories "Fluid System Puncture Only" and "Either Disabling Mechanical Damage or Fire" together comprise "M or F" kill.

This model calls for many values of $P_{12}(1,F)$ and $P_{12}(2,G)$. For example, when computing for $i = 4$, there are three previous bursts, leading to eight possible F's (seven not counting $F = \emptyset$) for which values of $P_{12}(1,F)$ are required. The same number of values of $P_{12}(2,G)$ would be required. As i increases, the number of associated F's and G's increases greatly. (When $i = 8$, there are 128 possible F's and 128 possible G's.) It is unlikely that

Table 7
Damage Categories and Their Probabilities of Occurrence
After i Bursts

Damage Category	Corresponding States (for all F,G in L_i)	Probability of Occurrence
Undamaged	$(\emptyset, \emptyset, 0)$	$P_i(\emptyset, \emptyset, 0)$
Fluid System Puncture Only	$(F, G, 0)$ $\{F, G \text{ not both} = \emptyset\}$	$P_i(F, G, 0)$ $F, G \text{ not both} = \emptyset$
Disabling Mechanical Damage Only	$(\emptyset, \emptyset, 1)$	$P_i(\emptyset, \emptyset, 1)$
Fire Only	$(*, 0)$	$P_i(*, 0)$
Fluid System Puncture, Disabling Mechanical Damage; No Fire	$(F, G, 1)$ $\{F, G \text{ not both} = \emptyset\}$	$P_i(F, G, 1)$ $F, G \text{ not both} = \emptyset$
Disabling Mechanical Damage and Fire	$(*, 1)$	$P_i(*, 1)$
Disabling Mechanical Damage	$(F, G, 1)$ $(*, 1)$	$P_i(*, 1) + P_i(F, G, 1)$ $F, G \text{ in } L_i$
Fire	$(*, 0)$ $(*, 1)$	$P_i(*, 0) + P_i(*, 1)$
Either Disabling Mechanical Damage or Fire	$(F, G, 1)$ $(*, 0)$ $(*, 1)$	$P_i(*, 0) + P_i(*, 1) + P_i(F, G, 1)$ $F, G \text{ in } L_i$

fluid ignition phenomena will ever be understood in enough detail to provide all of these probabilities. However, the model is still good. Since it provides for the greatest possible detail with respect to the puncture history, any less detailed history is imbedded in the model. For example, if the only available data give the probability of igniting spilled fluids in terms of the elapsed time since the first puncture, this can be handled by making $P_{12}(1,F)$ or $P_{12}(2,G)$ a function only of the time t_i and the earliest time in the set F or G.

3. NUMERICAL EXAMPLE

Find the probabilities of occurrence of the damage categories listed in Table 7 for the PUSHOVER vehicle for one, two and three bursts fired from the BULLY weapon. Make the computations for both the case where the basic damage events are assumed to be dependent, and the case where they are assumed to be independent. Also make a complete listing of the probabilities that the PUSHOVER is in each of the possible damage states after each burst. The other input conditions are as follows:

1. The PUSHOVER vehicle has two sinks, the crew compartment and the engine compartment.
2. There are six flammable fluid locations:
 - a. Right Fuel Tank
 - b. Left Fuel Tank
 - c. Left Fuel Line
 - d. Right Fuel Line
 - e. Engine Lubricant Reservoir
 - f. Hydraulic Cylinder & Lines
3. Locations a, b, c and d will spill fuel into the crew compartment if they are punctured by a burst of fire from the BULLY weapon. Locations e and f will spill their fluids into the engine compartment if they are punctured.

These first three sets of required information would generally be available from design specifications on the target vehicle.

4. The probabilities of puncturing each of the fluid locations on each of the bursts is given by this table:

	Burst 1	Burst 2	Burst 3
Right Fuel Tank	.115	.117	.113
Left Fuel Tank	.108	.109	.107
Left Fuel Line	.003	.004	.002
Right Fuel Line	.001	.001	.001
Engine Lubricant Reservoir	.075	.080	.065
Hydraulic Cylinder & Lines	.045	.050	.040

These probabilities are obtained from one of the standard vehicle vulnerability models.

5. The probabilities of an immediate catastrophic fire, given that each of these locations are punctured on each of the bursts is given by this table:

	Burst 1	Burst 2	Burst 3
Right Fuel Tank	.750	.760	.740
Left Fuel Tank	.650	.640	.660
Left Fuel Line	.500	.400	.600
Right Fuel Line	.300	.350	.250
Engine Lubricant Reservoir	.050	.060	.070
Hydraulic Cylinder & Lines	.040	.030	.050

These probabilities are obtained either from test data on fluid ignition, or from a theoretical model of such ignition.

6. The probabilities that each of the sinks are perforated on each of the bursts are given in this table:

	Burst 1	Burst 2	Burst 3
Crew Compartment	.450	.500	.400
Engine Compartment	.300	.350	.325

These probabilities are obtained from one of the standard vehicle vulnerability models.

7. The probabilities of igniting fluid spilled into each sink on previous bursts given that burst 2 perforates the sink are given in this table:

	Fluids Spilled on Burst 1
Crew Compartment	.250
Engine Compartment	.075

Similar probabilities for burst 3 are given in this table:

	Fluids Spilled on		
	Burst 1	Burst 2	Both 1 & 2
Crew Compartment	.275	.265	.285
Engine Compartment	.080	.070	.065

These probabilities are obtained either from test data on fluid ignition, or from a theoretical model of such ignition.

8. The probabilities of disabling mechanical damage on each of the bursts are given in this table:

	Burst 1	Burst 2	Burst 3
Disabling Mechanical Damage	.150	.170	.160

These probabilities are obtained from one of the standard vehicle vulnerability models.

9. The probabilities of igniting stowed ammunition on each of the bursts are given in this table:

	Burst 1	Burst 2	Burst 3
Igniting Stowed Ammunition	.100	.110	.090

These probabilities are obtained from one of the standard vehicle vulnerability models.

The input set corresponding to these conditions and prepared according to the instructions given in the comments in the program itself (APPENDIX A) is shown in Table 8.

The output of this run consists of five pages of line-printer output. The first page (Table 9) consists only of a recap of the input data, labeled so that it will be easy to check it for correctness. The second page (Table 10) lists the probabilities that the target vehicle is in each of the damage categories shown in Table 7, after the first burst, after the second burst, and after the third burst. Also shown are the more common kill probabilities in terms of M, F and K kills, and how they are related to the nine damage categories. Results are shown for both the assumption of dependent damage events and the assumption of independent damage events. If we had asked for only one of these assumptions, this page would have had the results for that assumption only. Tables 11, 12 and 13 show the probabilities that the vehicle is in each of the many damage states after each burst. These results may be omitted by the choice of the last input number.

Each page of machine output is labeled at the top with the first two input lines that allow for arbitrary user-supplied case descriptors. Each page of output is also labeled with the date and time that the machine run was made. This provides a further means of identifying runs and of matching input sets (output page 1) with output sets (output pages 2-5).

Table 8
Input File for Numerical Example

Target Vehicle - PUSHOVER

Threat Weapon - BULLY

3

2

6

.115, .108, .003, .001, .075, .045

.117, .109, .004, .001, .080, .050

.113, .107, .002, .001, .065, .040

.750, .650, .500, .300, .050, .040

.760, .640, .400, .350, .060, .030

.740, .660, .600, .250, .070, .050

4, 2

1, 2, 3, 4

5, 6

.450, .500, .400

.300, .350, .325

.250

.275, .265, .285

.075

.080, .070, .065

.150, .170, .160

.100, .110, .090

2

1

Table 9
First Output Page - Numerical Example

Target Vehicle - PUSHOVER
Threat Weapon - BULLY

I N P U T L I S T

Number of Bursts = 3 Number of Fluid Locations = 6 Number of Sinks = 2

Fluid Locations Draining into Sink 1: 1 2 3 4
Sink 2: 5 6

B U R S T

		1	2	3
Prob of a Fluid System Puncture (P9)	Loc 1	0.1150	0.1170	0.1130
	Loc 2	0.1080	0.1090	0.1070
	Loc 3	0.0030	0.0040	0.0020
	Loc 4	0.0010	0.0010	0.0010
	Loc 5	0.0750	0.0800	0.0650
	Loc 6	0.0450	0.0500	0.0400
Prob of Type I Fire/Puncture (P10)	Loc 1	0.7500	0.7600	0.7400
	Loc 2	0.6500	0.6400	0.6600
	Loc 3	0.5000	0.4000	0.5000
	Loc 4	0.3000	0.3500	0.2500
	Loc 5	0.0500	0.0600	0.0700
	Loc 6	0.0400	0.0300	0.0500
Prob of Disabling Mechanical Damage (P4)		0.1500	0.1700	0.1600
Prob of Fire Due to Hit on Ammunition (P6)		0.1000	0.1100	0.0900
Probability of Perforating Sinks (P11)	Sink 1	0.4500	0.5000	0.4000
	Sink 2	0.3000	0.3500	0.3250

Probability of Igniting Fluid Spilled on Set F of Previous Bursts,
Given a Perforation of the Appropriate Sink [P12(F)]

	F = t1	F = t2	F = t1t2
Burst 2, Sink 1	0.2500	--	--
Burst 3, Sink 1	0.2750	0.2650	0.2850
Burst 2, Sink 2	0.0750	--	--
Burst 3, Sink 2	0.0800	0.0700	0.0650

This run was made Sun Jan 12 14:26:41 EST 1986

Table 10
Second Output Page - Numerical Example

Target Vehicle - PUSHOVER
Threat Weapon - BULLY

O U T P U T L I S T

Calculations Made Assuming Dependent Events

	N U M B E R O F B U R S T S		
	1	2	3
1. Undamaged	0.40300	0.14468	0.06105
2. Puncture Only	0.18320	0.16793	0.11274
3. Mechanical Only	0.15000	0.14786	0.10920
4. Fire Only	0.26380	0.39289	0.41882
5. Puncture, Mechanical, No Fire	—	0.06025	0.09310
6. Mechanical, Fire	—	0.08639	0.20507
7. Mechanical	0.15000	0.29450	0.40738
8. Fire	0.26380	0.47927	0.62390
9. Either Mechanical or Fire	0.41380	0.68739	0.82620
Neither M, nor F, nor K (1)	0.40300	0.14468	0.06105
M or F, but not K (2 + 3 + 5)	0.33320	0.37605	0.31505
M or F (including K) (2 + 9)	0.59700	0.85532	0.93895
K (8)	0.26380	0.47927	0.62390

Calculations Made Assuming Independent Events

	N U M B E R O F B U R S T S		
	1	2	3
1. Undamaged	0.53134	0.26855	0.14551
2. Puncture Only	0.11384	0.12724	0.10508
3. Mechanical Only	0.09377	0.11210	0.10003
4. Fire Only	0.20482	0.30971	0.34203
5. Puncture, Mechanical, No Fire	0.02009	0.05312	0.07223
6. Mechanical, Fire	0.03614	0.12928	0.23512
7. Mechanical	0.15000	0.29450	0.40738
8. Fire	0.24096	0.43900	0.57715
9. Either Mechanical or Fire	0.35482	0.60421	0.74941
Neither M, nor F, nor K (1)	0.53134	0.26855	0.14551
M or F, but not K (2 + 3 + 5)	0.22769	0.29246	0.27734
M or F (including K) (2 + 9)	0.46866	0.73145	0.85449
K (8)	0.24096	0.43900	0.57715

This run was made Sun Jan 12 14:26:42 EST 1986

Table 11
Third Output Page - Numerical Example

Target Vehicle - PUSHOVER
Threat Weapon - BULLY

Individual State Probabilities - Dependent Events

F	G	--- Burst 1 ---		--- Burst 2 ---		--- Burst 3 ---	
		g = 0	g = 1	g = 0	g = 1	g = 0	g = 1
phi	phi	0.40300	0.15000	0.14468	0.14786	0.06105	0.10920
pni	t1	0.11445	--	0.03808	0.01946	0.01508	0.01691
phi	t2	--	--	0.04985	0.01856	0.01990	0.01835
phi	t3	--	--	--	--	0.01424	0.01456
phi	t1t2	--	--	0.01416	--	0.00568	0.00227
phi	t1t3	--	--	--	--	0.00375	0.00192
phi	t2t3	--	--	--	--	0.00491	0.00183
pni	t1t2t3	--	--	--	--	0.00139	--
t1	phi	0.06875	--	0.01609	0.01169	0.00502	0.00809
t1	t2	--	--	0.00850	--	0.00246	0.00136
t1	t3	--	--	--	--	0.00158	0.00115
t1	t2t3	--	--	--	--	0.00084	--
t2	phi	--	--	0.02836	0.01056	0.00896	0.00956
t2	t1	--	--	0.00805	--	0.00234	0.00129
t2	t3	--	--	--	--	0.00279	0.00104
t2	t1t3	--	--	--	--	0.00079	--
t3	pni	--	--	--	--	0.00974	0.00995
t3	t1	--	--	--	--	0.00256	0.00131
t3	t2	--	--	--	--	0.00336	0.00125
t3	t1t2	--	--	--	--	0.00095	--
t1t2	phi	--	--	0.00484	--	0.00149	0.00077
t1t2	t3	--	--	--	--	0.00048	--
t1t3	phi	--	--	--	--	0.00108	0.00079
t1t3	t2	--	--	--	--	0.00057	--
t2t3	phi	--	--	--	--	0.00191	0.00071
t2t3	t1	--	--	--	--	0.00054	--
t1t2t3	phi	--	--	--	--	0.00033	--
*		0.26380	--	0.39289	0.08639	0.41882	0.20507

This run was made Sun Jan 12 14:26:42 EST 1986

Table 12
Fourth Output Page - Numerical Example

Target Vehicle - PUSHOVER
Threat Weapon - BULLY

Individual State Probabilities - Independent Events

F	G	--- Burst 1 ---		--- Burst 2 ---		--- Burst 3 ---	
		g = 0	g = 1	g = 0	g = 1	g = 0	g = 1
phi	phi	0.53134	0.09377	0.26855	0.11210	0.14551	0.10003
phi	t1	0.06681	0.01179	0.03288	0.01373	0.01735	0.01193
phi	t2	--	--	0.03678	0.01525	0.01948	0.01339
phi	t3	--	--	--	--	0.01554	0.01068
pni	t1t2	--	--	0.00450	0.00188	0.00239	0.00164
pni	t1t3	--	--	--	--	0.00185	0.00127
phi	t2t3	--	--	--	--	0.00208	0.00143
pni	t1t2t3	--	--	--	--	0.00026	0.00018
t1	phi	0.04177	0.00737	0.01847	0.00771	0.00891	0.00612
t1	t1	0.00525	0.00093	0.00226	0.00094	0.00106	0.00073
t1	t2	--	--	0.00253	0.00106	0.00119	0.00082
t1	t3	--	--	--	--	0.00095	0.00065
t1	t1t2	--	--	0.00031	0.00013	0.00015	0.00010
t1	t1t3	--	--	--	--	0.00011	0.00008
t1	t2t3	--	--	--	--	0.00013	0.00009
t1	t1t2t3	--	--	--	--	0.00002	0.00001
t2	phi	--	--	0.02163	0.00903	0.01048	0.00720
t2	t1	--	--	0.00265	0.00111	0.00125	0.00086
t2	t2	--	--	0.00296	0.00124	0.00140	0.00096
t2	t3	--	--	--	--	0.00112	0.00077
t2	t1t2	--	--	0.00036	0.00015	0.00017	0.00012
t2	t1t3	--	--	--	--	0.00013	0.00009
t2	t2t3	--	--	--	--	0.00015	0.00010
t2	t1t2t3	--	--	--	--	0.00002	0.00001
t3	pni	--	--	--	--	0.01119	0.00769
t3	t1	--	--	--	--	0.00133	0.00092
t3	t2	--	--	--	--	0.00150	0.00103
t3	t3	--	--	--	--	0.00119	0.00082
t3	t1t2	--	--	--	--	0.00018	0.00013
t3	t1t3	--	--	--	--	0.00014	0.00010
t3	t2t3	--	--	--	--	0.00016	0.00011
t3	t1t2t3	--	--	--	--	0.00002	0.00001
t1t2	phi	--	--	0.00149	0.00062	0.00071	0.00049
t1t2	t1	--	--	0.00018	0.00008	0.00009	0.00006
t1t2	t2	--	--	0.00020	0.00009	0.00010	0.00007
t1t2	t3	--	--	--	--	0.00008	0.00005
t1t2	t1t2	--	--	0.00002	0.00001	0.00001	0.00001
t1t2	t1t3	--	--	--	--	0.00001	0.00001
t1t2	t2t3	--	--	--	--	0.00001	0.00001
t1t2	t1t2t3	--	--	--	--	0.00000	0.00000

Table Continued On Next Page

This run was made Sun Jan 12 14:26:42 EST 1986

Table 13
Fifth Output Page - Numerical Example

Target Vehicle - PUSHOVER
Threat Weapon - BULLY

Individual State Probabilities - Independent Events
(continued)

F	G	--- Burst 1 ---		--- Burst 2 ---		--- Burst 3 ---	
		g = 0	g = 1	g = 0	g = 1	g = 0	g = 1
t1t3	phi	--	--	--	--	0.00068	0.00047
t1t3	t1	--	--	--	--	0.00008	0.00006
t1t3	t2	--	--	--	--	0.00009	0.00006
t1t3	t3	--	--	--	--	0.00007	0.00005
t1t3	t1t2	--	--	--	--	0.00001	0.00001
t1t3	t1t3	--	--	--	--	0.00001	0.00001
t1t3	t2t3	--	--	--	--	0.00001	0.00001
t1t3	t1t2t3	--	--	--	--	0.00000	0.00000
t2t3	phi	--	--	--	--	0.00081	0.00055
t2t3	t1	--	--	--	--	0.00010	0.00007
t2t3	t2	--	--	--	--	0.00011	0.00007
t2t3	t3	--	--	--	--	0.00009	0.00006
t2t3	t1t2	--	--	--	--	0.00001	0.00001
t2t3	t1t3	--	--	--	--	0.00001	0.00001
t2t3	t2t3	--	--	--	--	0.00001	0.00001
t2t3	t1t2t3	--	--	--	--	0.00000	0.00000
t1t2t3	phi	--	--	--	--	0.00005	0.00004
t1t2t3	t1	--	--	--	--	0.00001	0.00000
t1t2t3	t2	--	--	--	--	0.00001	0.00001
t1t2t3	t3	--	--	--	--	0.00001	0.00000
t1t2t3	t1t2	--	--	--	--	0.00000	0.00000
t1t2t3	t1t3	--	--	--	--	0.00000	0.00000
t1t2t3	t2t3	--	--	--	--	0.00000	0.00000
t1t2t3	t1t2t3	--	--	--	--	0.00000	0.00000
*		0.20482	0.03614	0.30971	0.12928	0.34203	0.23512

This run was made Sun Jan 12 14:26:42 EST 1986

The damage categories whose probabilities of occurrence are given in Table 10 fall into three classes. These are:

Class 1 - Categories that cannot be entered from other categories, only left in moving to other categories.

Class 2 - Categories that can be both entered from other categories and left in moving to other categories.

Class 3 - Categories that can only be entered from other categories, but never left.

Of the categories listed, the only Class 1 category is "Undamaged." This is the initial state of the target before any firing. Class 2 categories are those representing only partial damage. These are "Puncture Only," "Mechanical Only," "Fire Only," and "Puncture, Mechanical, No Fire." Class 3 categories are those representing either partial or complete damage. These are "Mechanical, Fire," "Mechanical," "Fire," and "Either Mechanical or Fire." As the number of bursts increases, the probabilities associated with categories in these classes will change in different ways. Probabilities for Class 1 categories will always decrease, for subsequent bursts will always move the target out of the category, never into it. Probabilities for Class 2 categories will generally increase at first, but finally decrease, and, in the limit, become zero. This is because Class 2 categories can be entered from Class 1 categories or other Class 2 categories, and as the probabilities associated with these "feeder" classes decrease, there is less chance of the target entering the Class 2 category; it can only leave it. Probabilities for Class 3 categories always increase, approaching unity in the limit. If an infinite number of bursts are fired at the target, it will with complete certainty suffer both "Fire" and "Mechanical" damage.

These trends are noted in Table 10. although the probabilities for some of the Class 2 categories have not yet started to decrease after three bursts.

REFERENCES

1. Groves, Arthur D., "A Kill Probability Model for a Multiple-Burst Attack of a Vehicle, Where the Probability of Igniting Spilled Fuel is Time Dependent", AMSAA TR 132, June 1975, U.S. Army Materiel Analysis Activity, Aberdeen Proving Ground, MD 21005.

APPENDIX A

FORTRAN 77 Source Code

The next page is blank.

```

c      This program implements the methodology in this report for up to
c      three bursts. The code is written in FORTRAN 77. Instructions
c      for preparing the inputs are included as comments preceding each
c      of the "read" statements; all input is read in at the beginning
c      of the program. All numerical input is read using "List-Directed
c      READ" statements. (See the example in the report text.)
c
c      implicit real*8 (a-h, o-z)
c      character*80 ident1, ident2
c      character*60 today
c      common p1(3,2), p3(2,2:3,3), p4(3), p5(3,2), p(6,9), p6(3),
c      * p9(3,10), p10(3,10), p11(3,2), p12(2,2:3,3),
c      * q1(3,2), q3(2,2:3,3), q4(3), q5(3,2), q6(3),
c      * s(65,6), t(65,6), nis(2), isink(2,10), pbr1(3,4)
c      -----
c
c      The first information read is the date and time of the machine
c      run. At AMSAA, where this program is implemented on a VAX 11/780
c      with the UNIX operating system, this information is added to the
c      input file automatically by an executable script that identifies
c      for the program the input file name, and issues the command to
c      run. Therefore it should not be typed into the input file by the
c      user. If this program is implemented by other users at other
c      agencies, this information should be provided in whatever way is
c      appropriate, or else the "read" statement deleted from the code.
c
c      read(*,8000) today
c      8000 format(a60)
c      -----
c
c      The first user-supplied input consists of 2 lines
c      (up to 80 columns each) of arbitrary information to
c      identify or explain the case being run. Both lines
c      must be provided, even if one is empty.
c
c      read(*,8001) ident1
c      read(*,8001) ident2
c      8001 format(a80)
c      -----
c
c      The second input is a single integer telling the number
c      of bursts in the case being run.
c      The maximum allowable number is three.
c
c      read(*,*)nr
c      -----
c
c      The third input is a single integer telling the number
c      of sinks into which spilled fluid can collect.
c      The maximum allowable number is two.
c
c      read(*,*)nsinks
c      -----
c
c      The fourth input is a single integer telling the

```

```

c      number of fluid locations on the vehicle.
c      The maximum allowable number is 10.
c
c      read(*,*) nfl
c      -----
c
c      The fifth input consists of nr lines, one for each burst.
c      The ith line has nfl numbers, the jth of which
c      gives the probabilities p9 for the jth fluid location.
c      (p9 is the probability of puncturing the jth fluid location
c      on the ith burst.)
c
c      do 100 i = 1, nr
c        read(*,*)(p9(i,j),j=1,nfl)
c      100 continue
c      -----
c
c      The sixth input consists of nr lines, one for each burst.
c      The ith line has nfl numbers, the jth of which
c      gives the probabilities p10 for the jth fluid location.
c      (p10 is the probability of type 1 fire, given a puncture)
c
c      do 110 i = 1, nr
c        read(*,*)(p10(i,j),j=1,nfl)
c      110 continue
c      -----
c
c      The seventh input consist of two numbers; the first is
c      the number of fluid locations which, if punctured, will
c      drain into the first sink, and the second number is the
c      number of fluid locations which, if punctured, will
c      drain into the second sink.
c      If there is only one sink, this input should not be
c      provided: the program will automatically assign sink one
c      to all locations.
c
c      if( nsinks .eq. 2 ) read(*,*)( n1s(i), i = 1,2 )
c      -----
c
c      The eighth input consists of a mapping, telling which
c      fluid locations, if punctured, will drain into each sink.
c      If there is only one sink, nothing at all
c      needs to be input. The program assumes that all of the
c      fluid locations drain into that sink. If there are
c      two sinks, you must input 2 lines here; the first line
c      lists, as integers, the numbers of the fluid locations that
c      drain into the first sink, and the second line lists the
c      numbers of the fluid locations that drain into the second
c      sink.
c
c      if( nsinks .eq. 2 )then
c        do 120 i=1,2
c          read(*,*)(isink(i,j),j=1,n1s(i))
c        120 continue
c      else

```

```

        nis(1) = nfi
        do 130 j=1,nfi
            isink(1,j)=j
130      continue
    endif
c  -----
c
c      The ninth input consists of nsinks lines. The ith
c      of these lines gives pl1's, the probabilities that the ith
c      sink is perforated on each of the bursts.
c
c          do 140 j = 1, nsinks
c              read(*,*)( pl1(i,j), i=1, nr )
140      continue
c  -----
c
c      The tenth input is a set of lines giving the probabilities
c      of igniting fluids spilled on previous bursts
c      (pl2), for the second and third burst.
c
c      The first of these lines gives the probability pl2(1,2,F)
c      for F = 1. (for the second burst and the first sink.)
c
c      The second of these lines gives the probabilities pl2(1,3,F)
c      for F = 1, F = 2, and F = 1,2. (for the third
c      burst and the first sink.)
c
c      The third of these lines gives the probability pl2(2,2,F)
c      for F = 1. (for the second burst and the second sink.)
c
c      The fourth of these lines gives the probabilities pl2(2,3,F)
c      for F = 1, F = 2, and F = 1,2. (for the third
c      burst and the second sink.)
c
c      if( nr .gt. 1 ) then
c          do 160 i = 2,nr
c              m=2**(i-1)-1
c              do 150 j=1,m
c                  p3(2,i,j) = 0.
c                  q3(2,i,j) = 1.
150          continue
160      continue
c          do 190 k=1,nsinks
c              do 180 i = 2,nr
c                  m = 2**(i-1) - 1
c                  read(*,*)(pl2(k,i,j),j=1,m)
c                  do 170 j = 1, m
c                      p3(k,i,j) = pl1(i,k) * pl2(k,i,j)
c                      q3(k,i,j) = 1. - p3(k,i,j)
170          continue
180      continue
190  continue
c      endif
c  -----
c

```

```

c      The eleventh input line gives the probabilities
c      of disabling mechanical damage (p4) for
c      the first, second, and third burst.
c
c      read(*,*)(p4(i),i=1,nr)
c  -----
c
c      The twelvth input line gives the probabilities
c      of fire due to a hit on stowed ammunition (p6) for
c      the first, second, and third burst.
c
c      read(*,*)(p6(i),i=1,nr)
c          do 200 i = 1, nr
c              q4(i) = 1. - p4(i)
c              q6(i) = 1. - p6(i)
200      continue
c  -----
c      The thirteenth input line is an indicator telling whether
c      to calculate using the formulas for dependent events or
c      those for independent events. Input 0 for dependent events
c      only; input 1 for independent events only; and input 2
c      for both.
c
c      read(*,*)icor
c  -----
c      The last input line is an indicator telling whether to
c      print the probabilities of occurrence of the individual
c      vectors (states). Input 1 to print out these probabilities,
c      or 0 to not print them.
c
c      read(*,*)ipv
c  -----
c
c      Write out the entire input set for this run.
c
c  -----
c      write(*,8129) ident1
8128 format('1'a80)
c      write(*,8002) ident2
8002 format(' 'a80,/)
c  -----
c      write(*,8003)
8003 format(31x,'I N P U T   L I S T',)
c  -----
c      write(*,8004) nr, nfl, nsinks
8004 format(/' Number of Bursts =',i2,5x,
*          'Number of Fluid Locations =',i3,4x,
*          'Number of Sinks =',i2/)
c  -----
c      if(nsinks .eq. 2)then
c          do 210 i = 1, nsinks
c              if( i .eq. 1 )write(*,8005) i, (isink(i,j), j = 1,nis(1))
c              if( i .eq. 2 )write(*,8006) i, (isink(i,j), j = 1,nis(1))
210      continue
c          endif

```

```

8005 format(' Fluid Locations Draining Into Sink ',i1,':',i0i3)
8006 format('                               Sink ',i1,':',i0i3)
c - - - - -
      write(*,8007)
8007 format(6lx,'B U R S T',//53x,'1',10x,'2',10x,'3')
c - - - - -
      write(*,8008)(p9(i,1),i=1,nr)
8008 format('/' Prob of a Fluid System Puncture (P9)  Loc 1',
* 2x,3(f11.4))
      if( nfl .gt. 1)then
        do 220 j = 2, nfl
          write(*,8009)j,(p9(i,j),i=1,nr)
8009   format(38x,' Loc',i2,2x,3(f11.4))
        220   continue
      endif
c - - - - -
      write(*,8010)(p10(i,1),i=1,nr)
8010 format('/' Prob of Type I Fire/Puncture (P10)  Loc 1',
* 2x,3(f11.4))
      if( nfl .gt. 1)then
        do 230 j = 2, nfl
          write(*,8009)j,(p10(i,j),i=1,nr)
230   continue
      endif
c - - - - -
      write(*,8011)(p4(i),i=1,nr)
8011 format('/' Prob of Disabling Mechanical Damage (P4)',5x,3(f11.4))
c - - - - -
      write(*,8012)(p6(i),i=1,nr)
8012 format('/' Prob of Fire Due to Hit on Ammunition (P6)',3x,3(f11.4))
c - - - - -
      write(*,8013)(p11(i,1), i = 1,nr )
8013 format('/' Probability of Perforating Sinks (P11) Sink 1',3(f11.4))
      if(nsinks .eq. 2) write(*,8014) ( p11(i,2), i=1,nr )
8014 format('                               Sink 2',3(f11.4))
c - - - - -
      if( nr .gt. 1 ) then
        write(*,8015)
8015 format('/' Probability of Igniting Fluid Spilled on Set F',
* ' of Previous Bursts,')
* ' Given a Perforation of tne Appropriate Sink [P12(F)]')
        write(*,8016)
8016 format(/35x,'F = t1',6x,'F = t2',5x,'F = t1t2'/)
        do 250 k = 1,nsinks
          do 240 i = 2,nr
            m = 2**(i-1) - 1
            if(i.eq.2)write(*,8017)i,k,(p12(k,i,j),j=1,m)
8017   format(14x,'Burst',i2,', Sink',i2,5x,f7.4,2(5x,' -- '))
            if(i.eq.3)write(*,8018)i,k,(p12(k,i,j),j=1,m)
8018   format(14x,'Burst',i2,', Sink',i2,3(5x,f7.4))
          240   continue
        250   continue
      endif
c - - - - -
      write(*,8019) today

```

```

8019 format(// ' This run was made ',a00)
c -----
      do 270 j = 1,6
        do 260 i = 1,9
          p(j,i) = 0.
260      continue
270      continue
      write(*,8128) ident1
      write(*,8002) ident2
      write(*,8021)
8021 format(/29x,'O U T P U T   L I S T',/)
      do 290 j = 1,28
        do 280 k = 1,6
          s(j,k) = 0.0
280      continue
290      continue
c
      if(icor.ne.1)then
c      perform calculations for case of DEPENDENT events
c
c      combine p9's and pl0's appropriately.
c
      do 320 k = 1, 2
        do 310 i = 1, nr
          pl(i,k) = 0.
          p5(i,k) = 0.
          if( k .eq. 1 .or. nsinks .eq. 2 ) then
            do 300 j = 1, nis(k)
              m = isink(k,j)
              pl(i,k) = pl(i,k) + p9(i,m)
              p5(i,k) = p5(i,k) + p9(i,m) * pl0(i,m)
300          continue
            endif
310        continue
320      continue
c
c ***** calculate state probabilities for first burst *****
c *****DEPENDENT*****
c
c -----
c      call pd1
c -----
c      if( nr .gt. 1 ) then
c
c ***** calculate state probabilities for second burst *****
c *****DEPENDENT*****
c
c -----
c      call pd2
c -----
c      endif
c      if( nr .gt. 2 ) then
c
c ***** calculate state probabilities for third burst *****
c *****DEPENDENT*****

```

```

c
c -----
      call pd3
c -----
      endif
      write(*,8022)
8022 format(/19x,'Calculations Made Assuming Dependent Events'//
      * 42x,'N U M B E R   O F   B U R S T S'//
      * 47x,'1',9x,'2',9x,'3'//)
      write(*,8023) (p(i,1),i=1,nr)
8023 format(8x,'1. Undamaged',3(f10.5))
      write(*,8024) (p(i,2),i=1,nr)
8024 format(8x,'2. Puncture Only',3(f10.5))
      write(*,8025) (p(i,3),i=1,nr)
8025 format(8x,'3. Mechanical Only',3(f10.5))
      write(*,8026) (p(i,4),i=1,nr)
8026 format(8x,'4. Fire Only',3(f10.5))
      if( nr .eq. 1 )write(*,8027)
8027 format(8x,'5. Puncture, Mechanical, No Fire', ' -- ')
      if( nr .ne. 1 )write(*,8028) (p(i,5),i=2,nr)
8028 format(8x,'5. Puncture, Mechanical, No Fire', ' -- ',
      * 2(f10.5))
      if( nr .eq. 1 )write(*,8029)
8029 format(8x,'6. Mechanical, Fire', ' -- ')
      if( nr .ne. 1 )write(*,8030) (p(i,6),i=2,nr)
8030 format(8x,'6. Mechanical, Fire', ' -- ',
      * 2(f10.5))
      write(*,8031) (p(i,7),i=1,nr)
8031 format(8x,'7. Mechanical',3(f10.5))
      write(*,8032) (p(i,8),i=1,nr)
8032 format(8x,'8. Fire',3(f10.5))
      write(*,8033) (p(i,9),i=1,nr)
8033 format(8x,'9. Either Mechanical or Fire',3(f10.5))
      do 330 i=1,nr
        pbrl(i,1) = p(i,1)
        pbrl(i,2) = p(i,2) + p(i,3) + p(i,5)
        pbrl(i,3) = p(i,9) + p(i,2)
        pbrl(i,4) = p(i,8)
      330 continue
      write(*,8034) (pbrl(i,1),i=1,nr)
8034 format(/9x,'Neither M, nor F, nor K (1)',3(f10.5))
      write(*,8035) (pbrl(i,2),i=1,nr)
8035 format(9x,'M or F, but not K (2 + 3 + 5)',3(f10.5))
      write(*,8036) (pbrl(i,3),i=1,nr)
8036 format(9x,'M or F (including K) (2 + 9)',3(f10.5))
      write(*,8037) (pbrl(i,4),i=1,nr)
8037 format(9x,'K (8)',3(f10.5)///)
c
      endif
      if(icor.ne.0)then
c      perform calculations for case of independent events
c
      do 350 j = 1,3
        do 340 i = 1,9
          p(j,i) = 0.

```

```

340         continue
350         continue
c
c         combine p9's and p10's appropriately.
c
      do 380 k = 1, 2
      do 370 i = 1, nr
      q1(i,k) = 1.
      q5(i,k) = 1.
      if( k .eq. 1 .or. nsinks .eq. 2 ) then
      do 360 j = 1, nis(k)
      m = isink(k,j)
      q1(i,k) = q1(i,k) * ( 1. - p9(i,m) )
      q5(i,k) = q5(i,k) * ( 1. - p9(i,m) * p10(i,m) )
360         continue
      endif
      p1(i,k) = 1. - q1(i,k)
      p5(i,k) = 1. - q5(i,k)
370         continue
380         continue
c
c ***** calculate state probabilities for first burst *****
c *****INDEPENDENT*****
c
c -----
c         call pi1
c -----
c         if ( nr .gt. 1 ) then
c
c ***** calculate state probabilities for second burst *****
c *****INDEPENDENT*****
c
c -----
c         call pi2
c -----
c         endif
c         if ( nr .gt. 2 ) then
c
c ***** calculate state probabilities for third burst *****
c *****INDEPENDENT*****
c
c -----
c         call pi3
c -----
c         endif
c         write(*,8038)
8038 format(//10x,'Calculations Made Assuming Independent Events'//
* 42x,'N U M B E R   O F   B U R S T S'//
* 4/x,'1',9x,'2',9x,'3'//)
c         write (*,8023) (p(i,1),i=1,nr)
c         write (*,8024) (p(i,2),i=1,nr)
c         write (*,8025) (p(i,3),i=1,nr)
c         write (*,8026) (p(i,4),i=1,nr)
c         write (*,8039) (p(i,5),i=1,nr)
8039 format(0x,'5. Puncture, Mechanical, No Fire',3(f10.5))

```

```

      write (*,8040) (p(i,6),i=1,nr)
8040 format(8x,'o. Mechanical, Fire',3(f10.5))
      write (*,8031) (p(i,7),i=1,nr)
      write (*,8032) (p(i,8),i=1,nr)
      write (*,8033) (p(i,9),i=1,nr)
      do 390 i=1,nr
        pbrl(i,1) = p(i,1)
        pbrl(i,2) = p(i,2) + p(i,3) + p(i,5)
        pbrl(i,3) = p(i,9) + p(i,2)
        pbrl(i,4) = p(i,8)
390    continue
      write(*,8034) (pbrl(i,1),i=1,nr)
      write(*,8035) (pbrl(i,2),i=1,nr)
      write(*,8036) (pbrl(i,3),i=1,nr)
      write(*,8037) (pbrl(i,4),i=1,nr)
      endif
      write(*,8019) today
        if(ipv.eq.0)goto 410
        do 400 i = 1,2
          if(i.eq.1 .and. icor.eq.1)goto 400
          if(i.eq.2 .and. icor.eq.0)goto 400
          if(1.eq.1 .or. nsinks.eq.2)then
            write(*,8128) ident1
            write(*,8002) ident2
          else
            write(*,8041)
8041 format(///// )
          endif
          if(i .eq. 1) write(*,8042)
8042 format(16x,'Individual State Probabilities - Dependent Events')
          if(i .eq. 2) write(*,8043)
8043 format(15x,'Individual State Probabilities - Independent Events')
          write(*,8044)
8044 format(/21x,'--- Burst 1 ---',7x,'--- Burst 2 ---',7x,
* '--- Burst 3 ---')
c
      write(*,8045)
8045 format(/6x,'F   G',10x,'g = 0   g = 1',8x,'g = 0   g = 1'
*      ,8x,'g = 0   g = 1'/)
      if( i .eq. 1 ) then
c
        write(*,8046)s(1,1),s(1,4),s(1,2),s(1,5),s(1,3),s(1,6)
8046 format(5x,'phi phi',2x,3(4x,2f9.5))
c
        if ( nsinks .eq. 2 ) then
          write(*,8047)s(33,1),s(33,2),s(33,5),s(33,3),s(33,6)
8047 format(4x,' phi t1',7x,f9.5,'    -- ',2(4x,2f9.5))
c
          write(*,8048)s(9,2),s(9,5),s(9,3),s(9,6)
8048 format(4x,' phi t2',7x,2('    -- '),2(4x,2f9.5))
c
          write(*,8049)s(3,3),s(3,6)
8049 format(5x,'pni t3',3x,2(4x,2('    -- '),4x,2f9.5))
c
          write(*,8050)s(41,2),s(41,3),s(41,6)

```

```

8050 format(5x,'phi tlt2',5x,2(' -- '),4x,f9.5,' -- ',
* 4x,2f9.5)
c
write(*,8051)s(35,3),s(35,6)
8051 format(5x,'pni tlt3',5x,2(' -- '),4x,2(' -- '),4x,2f9.5)
c
write(*,8052)s(11,3),s(11,6)
8052 format(5x,'pni t2t3',5x,2(' -- '),4x,2(' -- '),4x,2f9.5)
c
write(*,8053)s(43,3)
8053 format(5x,'phi tlt2t3',3x,2(2(' -- '),4x),f9.5,' -- ')
endif
c
write(*,8054)s(17,1),s(17,2),s(17,5),s(17,3),s(17,6)
8054 format(5x,' t1 phi',6x,f9.5,' -- ',2(4x,2f9.5))
c
if ( nsinks .eq. 2 ) then
write(*,8055)s(25,2),s(25,3),s(25,6)
8055 format(6x,'t1 t2',7x,2(' -- '),4x,f9.5,' -- ',4x,2f9.5)
c
write(*,8056)s(19,3),s(19,6)
8056 format(6x,'t1 t3',7x,2(' -- '),4x,2(' -- '),4x,2f9.5)
c
write(*,8057)s(27,3)
8057 format(6x,'t1 t2t3',5x,2(2(' -- '),4x),f9.5,' -- ')
endif
c
write(*,8058)s(5,2),s(5,5),s(5,3),s(5,6)
8058 format(5x,' t2 phi',6x,2(' -- '),2(4x,2f9.5))
c
if( nsinks .eq. 2 ) then
write(*,8059)s(37,2),s(37,3),s(37,6)
8059 format(6x,'t2 t1',7x,2(' -- '),4x,f9.5,' -- ',4x,2f9.5)
c
write(*,8060)s(7,3),s(7,6)
8060 format(6x,'t2 t3',7x,2(' -- '),4x,2(' -- '),4x,2f9.5)
c
write(*,8061)s(39,3)
8061 format(6x,'t2 tlt3',5x,2(2(' -- '),4x),f9.5,' -- ')
endif
c
write(*,8062)s(2,3),s(2,6)
8062 format(5x,' t3 phi',6x,2(' -- '),4x,2(' -- '),
* 2(4x,2f9.5))
c
if ( nsinks .eq. 2 ) then
write(*,8063)s(34,3),s(34,6)
8063 format(6x,'t3 t1',7x,2(' -- '),4x,2(' -- '),4x,2f9.5)
c
write(*,8064)s(10,3),s(10,6)
8064 format(6x,'t3 t2',7x,2(' -- '),4x,2(' -- '),4x,2f9.5)
c
write(*,8065)s(42,3)
8065 format(6x,'t3 tlt2',5x,2(2(' -- '),4x),f9.5,' -- ')
endif

```

```

c
  write(*,8066)s(21,2),s(21,3),s(21,6)
8066 format(4x,'tlt2 pni',6x,2('  -- '),4x,f9.5,'  -- ',
*      4x,2f9.5)
c
  if ( nsinks .eq. 2 ) then
    write(*,8067)s(23,3)
8067 format(4x,'tlt2 t3',7x,2(2('  -- '),4x),f9.5,'  -- ')
    endif
c
  write(*,8068)s(18,3),s(18,6)
8068 format(4x,'tlt3 phi',6x,2('  -- '),4x,2('  -- '),
*      4x,2f9.5)
c
  if ( nsinks .eq. 2 ) then
    write(*,8069)s(26,3)
8069 format(4x,'tlt3 t2',7x,2(2('  -- '),4x),f9.5,'  -- ')
    endif
c
  write(*,8070)s(6,3),s(6,6)
8070 format(4x,'t2t3 pni',6x,2('  -- '),4x,2('  -- '),
*      4x,2f9.5)
c
  if ( nsinks .eq. 2 ) then
    write(*,8071)s(38,3)
8071 format(4x,'t2t3 t1',7x,2(2('  -- '),4x),f9.5,'  -- ')
    endif
c
  write(*,8072)s(22,3)
8072 format(2x,'tlt2t3 phi',6x,2(2('  -- '),4x),f9.5,'  -- ')
c
  write(*,8073)s(65,1),s(65,2),s(65,5),s(65,3),s(65,6)
8073 format(8x,'*',9x,f9.5,('  -- '),2(4x,2f9.5))
c
  if ( nsinks .eq. 2 ) write(*,8019) today
  else
c
  start here for INDEPENDENT events
c
  write(*,8046)t(1,1),t(1,4),t(1,2),t(1,5),t(1,3),t(1,6)
c8046 format(5x,'phi phi',1x,3(4x,2f9.5))
c
  if ( nsinks .eq. 2 ) then
    write(*,8074)t(33,1),t(33,4),t(33,2),t(33,5),t(33,3),t(33,6)
8074 format(4x,' phi t1',7x,2f9.5,2(4x,2f9.5))
c
  write(*,8048)t(9,2),t(9,5),t(9,3),t(9,6)
c8048 format(4x,' phi t2',7x,2('  -- '),2(4x,2f9.5))
c
  write(*,8049)t(3,3),t(3,6)
c8049 format(5x,'phi t3',2x,2(4x,2('  -- ')),4x,2f9.5)
c
  write(*,8075)t(41,2),t(41,5),t(41,3),t(41,6)
8075 format(5x,'phi tlt2',5x,2('  -- '),2(4x,2f9.5))
c

```

```

        write(*,8051)t(35,3),t(35,6)
c8051 format(5x,'phi tlt3',5x,2('    -- '),4x,2('    -- '),
c      *      4x,2f9.5)
c
        write(*,8052)t(11,3),t(11,6)
c8052 format(5x,'phi t2t3',5x,2('    -- '),4x,2('    -- '),
c      *      4x,2f9.5)
c
        write(*,8076)t(43,3),t(43,6)
8076 format(5x,'phi tlt2t3',3x,2(2('    -- '),4x),2f9.5)
        endif
c
        write(*,8077)t(17,1),t(17,4),t(17,2),t(17,5),t(17,3),t(17,6)
8077 format(5x,' t1 phi',6x,2f9.5,2(4x,2f9.5))
c
        if ( nsinks .eq. 2 ) then
            write(*,8078)t(49,1),t(49,4),t(49,2),t(49,5),t(49,3),t(49,6)
8078 format(5x,' t1 t1',7x,2f9.5,2(4x,2f9.5))
c
            write(*,8079)t(25,2),t(25,5),t(25,3),t(25,6)
8079 format(6x,'t1 t2',7x,2('    -- '),2(4x,2f9.5))
c
            write(*,8056)t(19,3),t(19,6)
c8056 format(6x,'t1 t3',7x,2('    -- '),4x,2('    -- '),4x,2f9.5)
c
            write(*,8080)t(57,2),t(57,5),t(57,3),t(57,6)
8080 format(6x,'t1 tlt2',5x,2('    -- '),2(4x,2f9.5))
c
            write(*,8081)t(51,3),t(51,6)
8081 format(6x,'t1 tlt3',5x,2(2('    -- '),4x),2f9.5)
c
            write(*,8082)t(27,3),t(27,6)
8082 format(6x,'t1 t2t3',5x,2(2('    -- '),4x),2f9.5)
c
            write(*,8083)t(59,3),t(59,6)
8083 format(6x,'t1 tlt2t3',3x,2(2('    -- '),4x),2f9.5)
            endif
c
            write(*,8058)t(5,2),t(5,5),t(5,3),t(5,6)
c8058 format(5x,' t2 phi',6x,2('    -- '),2(4x,2f9.5))
c
            if ( nsinks .eq. 2 ) then
                write(*,8084)t(37,2),t(37,5),t(37,3),t(37,6)
8084 format(6x,'t2 t1',7x,2('    -- '),2(4x,2f9.5))
c
                write(*,8085)t(13,2),t(13,5),t(13,3),t(13,6)
8085 format(6x,'t2 t2',7x,2('    -- '),2(4x,2f9.5))
c
                write(*,8060)t(7,3),t(7,6)
c8060 format(6x,'t2 t3',7x,2('    -- '),4x,2('    -- '),4x,2f9.5)
c
                write(*,8086)t(45,2),t(45,5),t(45,3),t(45,6)
8086 format(6x,'t2 tlt2',5x,2('    -- '),2(4x,2f9.5))
c
                write(*,8087)t(39,3),t(39,6)

```

```

8087 format(6x,'t2 tlt3',5x,2(2('    -- '),4x),2f9.5)
c
    write(*,8088)t(15,3),t(15,6)
8088 format(6x,'t2 t2t3',5x,2('    -- '),4x,2('    -- '),4x,2f9.5)
c
    write(*,8089)t(47,3),t(47,6)
8089 format(6x,'t2 tlt2t3',3x,2('    -- '),4x,2('    -- ')
*      ,4x,2f9.5)
    endif
c
    write(*,8062)t(2,3),t(2,6)
c8062 format(5x,' t3 phi',6x,2('    -- '),4x,2('    -- '),
c *      2(4x,2f9.5))
c
    if ( nsinks .eq. 2 ) then
        write(*,8063)t(34,3),t(34,6)
c8063 format(6x,'t3 t1',7x,2('    -- '),4x,2('    -- '),4x,2f9.5)
c
        write(*,8064)t(10,3),t(10,6)
c8064 format(6x,'t3 t2',7x,2('    -- '),4x,2('    -- '),4x,2f9.5)
c
        write(*,8090)t(4,3),t(4,6)
8090 format(6x,'t3 t3',7x,2('    -- '),4x,2('    -- '),4x,2f9.5)
c
        write(*,8091)t(42,3),t(42,6)
8091 format(6x,'t3 tlt2',5x,2(2('    -- '),4x),2f9.5)
c
        write(*,8092)t(36,3),t(36,6)
8092 format(6x,'t3 tlt3',5x,2(2('    -- '),4x),2f9.5)
c
        write(*,8093)t(12,3),t(12,6)
8093 format(6x,'t3 t2t3',5x,2(2('    -- '),4x),2f9.5)
c
        write(*,8094)t(44,3),t(44,6)
8094 format(6x,'t3 tlt2t3',3x,2(2('    -- '),4x),2f9.5)
        endif
c
        write(*,8095)t(21,2),t(21,5),t(21,3),t(21,6)
8095 format(4x,'tlt2 phi',6x,2('    -- '),2(4x,2f9.5))
c
        if ( nsinks .eq. 2 ) then
            write(*,8096)t(53,2),t(53,5),t(53,3),t(53,6)
8096 format(4x,'tlt2 t1',7x,2('    -- '),2(4x,2f9.5))
c
            write(*,8097)t(29,2),t(29,5),t(29,3),t(29,6)
8097 format(4x,'tlt2 t2',7x,2('    -- '),2(4x,2f9.5))
c
            write(*,8098)t(23,3),t(23,6)
8098 format(4x,'tlt2 t3',7x,2(2('    -- '),4x),2f9.5)
c
            write(*,8099)t(61,2),t(61,5),t(61,3),t(61,6)
8099 format(4x,'tlt2 tlt2',5x,2('    -- '),2(4x,2f9.5))
c
            write(*,8100)t(55,3),t(55,6)
8100 format(4x,'tlt2 tlt3',5x,2(2('    -- '),4x),2f9.5)

```

```

c      write(*,8101)t(31,3),t(31,6)
8101 format(4x,'t1t2 t2t3',5x,2(2('    -- '),4x),2f9.5)
c      write(*,8102)t(63,3),t(63,6)
8102 format(4x,'t1t2 t1t2t3',3x,2(2('    -- '),4x),2f9.5)
c      write(*,8103)
8103 format(///51x,'Table Continued On Next Page'/)
      write(*,8019) today
      write(*,8128) ident1
      write(*,8002) ident2
      write(*,8043)
      write(*,8104)
8104 format(35x,'(continued)')
      write(*,8044)
      write(*,8045)
      endif
c      write(*,8068)t(18,3),t(18,6)
c8068 format(4x,'t1t3 phi',6x,2('    -- '),4x,2('    -- '),
c      *      4x,2f9.5)
c      if ( nsinks .eq. 2 ) then
      write(*,8105)t(50,3),t(50,6)
8105 format(4x,'t1t3 t1',7x,2('    -- '),4x,2('    -- '),4x,2f9.5)
c      write(*,8106)t(26,3),t(26,6)
8106 format(4x,'t1t3 t2',7x,2(2('    -- '),4x),2f9.5)
c      write(*,8107)t(20,3),t(20,6)
8107 format(4x,'t1t3 t3',7x,2(2('    -- '),4x),2f9.5)
c      write(*,8108)t(58,3),t(58,6)
8108 format(4x,'t1t3 t1t2',5x,2(2('    -- '),4x),2f9.5)
c      write(*,8109)t(52,3),t(52,6)
8109 format(4x,'t1t3 t1t3',5x,2(2('    -- '),4x),2f9.5)
c      write(*,8110)t(28,3),t(28,6)
8110 format(4x,'t1t3 t2t3',5x,2(2('    -- '),4x),2f9.5)
c      write(*,8111)t(60,3),t(60,6)
8111 format(4x,'t1t3 t1t2t3',3x,2(2('    -- '),4x),2f9.5)
      endif
c      write(*,8070)t(6,3),t(6,6)
c8070 format(4x,'t2t3 phi',6x,2('    -- '),4x,2('    -- '),
c      *      4x,2f9.5)
c      if ( nsinks .eq. 2 ) then
      write(*,8112)t(38,3),t(38,6)
8112 format(4x,'t2t3 t1',7x,2(2('    -- '),4x),2f9.5)
c      write(*,8113)t(14,3),t(14,6)

```

```

8113 format(4x,'t2t3 t2',7x,2(2('    --  '),4x),2f9.5)
c
    write(*,8114)t(8,3),t(8,6)
8114 format(4x,'t2t3 t3',7x,2(2('    --  '),4x),2f9.5)
c
    write(*,8115)t(46,3),t(46,6)
8115 format(4x,'t2t3 tlt2',5x,2(2('    --  '),4x),2f9.5)
c
    write(*,8116)t(40,3),t(40,6)
8116 format(4x,'t2t3 tlt3',5x,2(2('    --  '),4x),2f9.5)
c
    write(*,8117)t(16,3),t(16,6)
8117 format(4x,'t2t3 t2t3',5x,2(2('    --  '),4x),2f9.5)
c
    write(*,8118)t(48,3),t(48,6)
8118 format(4x,'t2t3 tlt2t3',3x,2(2('    --  '),4x),2f9.5)
endif
c
    write(*,8119)t(22,3),t(22,6)
8119 format(2x,'tlt2t3 phi',6x,2(2('    --  '),4x),2f9.5)
c
    if ( nsinks .eq. 2 ) then
        write(*,8120)t(54,3),t(54,6)
8120 format(2x,'tlt2t3 t1',7x,2(2('    --  '),4x),2f9.5)
c
        write(*,8121)t(30,3),t(30,6)
8121 format(2x,'tlt2t3 t2',7x,2(2('    --  '),4x),2f9.5)
c
        write(*,8122)t(24,3),t(24,6)
8122 format(2x,'tlt2t3 t3',7x,2(2('    --  '),4x),2f9.5)
c
        write(*,8123)t(62,3),t(62,6)
8123 format(2x,'tlt2t3 tlt2',5x,2(2('    --  '),4x),2f9.5)
c
        write(*,8124)t(56,3),t(56,6)
8124 format(2x,'tlt2t3 tlt3',5x,2(2('    --  '),4x),2f9.5)
c
        write(*,8125)t(32,3),t(32,6)
8125 format(2x,'tlt2t3 t2t3',5x,2(2('    --  '),4x),2f9.5)
c
        write(*,8126)t(64,3),t(64,6)
8126 format(2x,'tlt2t3 tlt2t3',3x,2(2('    --  '),4x),2f9.5)
endif
c
    write(*,8127)t(65,1),t(65,4),t(65,2),t(65,5),t(65,3),t(65,6)
8127 format(8x,'*',5x,3(4x,2f9.5))
c
    write(*,8019) today
endif
400    continue
410    continue
stop
end

```

```

subroutine pdl
c
c ***** calculate state probabilities for first burst *****
c *****DEPENDENT EVENTS*****
c
  implicit real*8 (a-h, o-z)
  common pl(3,2), p3(2,2:3,3), p4(3), p5(3,2), p(6,9), p6(3),
  * p9(3,10), pl0(3,10), pl1(3,2), pl2(2,2:3,3),
  * q1(3,2), q3(2,2:3,3), q4(3), q5(3,2), q6(3),
  * s(65,6), t(65,6), nis(2), isink(2,10)
c
c -----
c   phi  phi  0          Table 5    Formula 1
c
c   s(1,1) = 1. - pl(1,1) - pl(1,2) - p4(1) - p6(1)
c
c           p(1,1) = p(1,1) + s(1,1)
c -----
c   t1  pni  0          Table 5    Formula 2
c
c   s(17,1) = pl(1,1) - p5(1,1)
c
c           p(1,2) = p(1,2) + s(17,1)
c -----
c   pni  t1  0          Table 5    Formula 3
c
c   s(33,1) = pl(1,2) - p5(1,2)
c
c           p(1,2) = p(1,2) + s(33,1)
c -----
c   star  0          Table 5    Formula 4
c
c   s(65,1) = p5(1,1) + p5(1,2) + p6(1)
c
c           p(1,4) = p(1,4) + s(65,1)
c           p(1,8) = p(1,8) + s(65,1)
c           p(1,9) = p(1,9) + s(65,1)
c -----
c   phi  pni  1          Table 5    Formula 5
c
c   s(1,4) = p4(1)
c
c           p(1,3) = p(1,3) + s(1,4)
c           p(1,7) = p(1,7) + s(1,4)
c           p(1,9) = p(1,9) + s(1,4)
c -----
c   t1  pni  1          Table 5    Formula 6
c
c   s(17,4) = 0.
c
c           p(1,5) = p(1,5) + s(17,4)
c           p(1,7) = p(1,7) + s(17,4)
c           p(1,9) = p(1,9) + s(17,4)
c -----
c   pni  t1  i          Table 5    Formula 7
c

```

```

s(33,4) = 0.
c
      p(1,5) = p(1,5) + s(33,4)
      p(1,7) = p(1,7) + s(33,4)
      p(1,9) = p(1,9) + s(33,4)
c - - - - -
c   star 1           Table 5   Formula 8
c
      s(65,4) = 0.
c
      p(1,6) = p(1,6) + s(65,4)
      p(1,7) = p(1,7) + s(65,4)
      p(1,8) = p(1,8) + s(65,4)
      p(1,9) = p(1,9) + s(65,4)
c - - - - -
      ptot = p(1,1) + p(1,2) + p(1,3) + p(1,4) + p(1,5) + p(1,6)
      if( abs( 1. - ptot ) .gt. .000001) write(*,100)ptot
100 format(' sum of DEPENDENT probabilities for 1 burst is ',f10.7)
      return
      end

```

```

subroutine pd2
c
c ***** calculate state probabilities for second burst *****
c *****DEPENDENT EVENTS*****
c
  implicit real*8 (a-h, o-z)
  common pl(3,2), p3(2,2:3,3), p4(3), p5(3,2), p(6,9), p6(3),
  * p9(3,10), pl0(3,10), pl1(3,2), pl2(2,2:3,3),
  * q1(3,2), q3(2,2:3,3), q4(3), q5(3,2), q6(3),
  * s(65,6), t(65,6), nis(2), isink(2,10)
c -----
c   phi phi 0          Table 5   Formula 1
c
c   s(1,2) = s(1,1) * ( 1. - pl(2,1) - pl(2,2) - p4(2) - p6(2) )
c
c           p(2,1) = p(2,1) + s(1,2)
c -----
c   t2 phi 0          Table 5   Formula 2
c
c   s(5,2) = s(1,1) * ( pl(2,1) - p5(2,1) )
c
c           p(2,2) = p(2,2) + s(5,2)
c -----
c   phi t2 0          Table 5   Formula 3
c
c   s(9,2) = s(1,1) * ( pl(2,2) - p5(2,2) )
c
c           p(2,2) = p(2,2) + s(9,2)
c -----
c   t1 phi 0          Table 5   Formula 1
c
c   s(17,2) = s(17,1) * ( 1. - pl(2,1) - pl(2,2)
  *                - p3(1,2,1) - p4(2) - p6(2) )
c
c           p(2,2) = p(2,2) + s(17,2)
c -----
c   t1t2 phi 0        Table 5   Formula 2
c
c   s(21,2) = s(17,1) * ( pl(2,1) - p5(2,1) )
c
c           p(2,2) = p(2,2) + s(21,2)
c -----
c   t1 t2 0          Table 5   Formula 3
c
c   s(25,2) = s(17,1) * ( pl(2,2) - p5(2,2) )
c
c           p(2,2) = p(2,2) + s(25,2)
c -----
c   phi t1 0          Table 5   Formula 1
c
c   s(33,2) = s(33,1) * ( 1. - pl(2,1) - pl(2,2)
  *                - p3(2,2,1) - p4(2) - p6(2) )
c
c           p(2,2) = p(2,2) + s(33,2)
c -----

```

```

c      t2 t1 0          Table 5   Formula 2
c
c      s(37,2) = s(33,1) * ( p1(2,1) - p5(2,1) )
c
c      p(2,2) = p(2,2) + s(37,2)
c -----
c      phi t1t2 0          Table 5   Formula 3
c
c      s(41,2) = s(33,1) * ( p1(2,2) - p5(2,2) )
c
c      p(2,2) = p(2,2) + s(41,2)
c -----
c      star 0          Table 5   Formula 4
c
c      s(65,2) = s(65,1) * q4(2)
c      *      + s(1,1) * ( p5(2,1) + p5(2,2) + p6(2) )
c      *      + s(17,1) * ( p5(2,1) + p5(2,2)
c      *      + p3(1,2,1) + p6(2) )
c      *      + s(33,1) * ( p5(2,1) + p5(2,2)
c      *      + p3(2,2,1) + p6(2) )
c
c      p(2,4) = p(2,4) + s(65,2)
c      p(2,8) = p(2,8) + s(65,2)
c      p(2,9) = p(2,9) + s(65,2)
c -----
c      pni phi 1          Table 5   Formula 5
c
c      s(1,5) = s(1,1) * p4(2) + s(1,4) * ( 1. - p1(2,1)
c      *      - p1(2,2) - p6(2) )
c
c      p(2,3) = p(2,3) + s(1,5)
c      p(2,7) = p(2,7) + s(1,5)
c      p(2,9) = p(2,9) + s(1,5)
c -----
c      t2 pni 1          Table 5   Formula 6
c
c      s(5,5) = s(1,4) * ( p1(2,1) - p5(2,1) )
c
c      p(2,5) = p(2,5) + s(5,5)
c      p(2,7) = p(2,7) + s(5,5)
c      p(2,9) = p(2,9) + s(5,5)
c -----
c      phi t2 1          Table 5   Formula 7
c
c      s(9,5) = s(1,4) * ( p1(2,2) - p5(2,2) )
c
c      p(2,5) = p(2,5) + s(9,5)
c      p(2,7) = p(2,7) + s(9,5)
c      p(2,9) = p(2,9) + s(9,5)
c -----
c      t1 pni 1          Table 5   Formula 5
c
c      s(17,5) = s(17,1) * p4(2) + s(17,4) * ( 1. - p1(2,1)
c      *      - p1(2,2) - p3(1,2,1) - p6(2) )
c

```

```

p(2,5) = p(2,5) + s(17,5)
p(2,7) = p(2,7) + s(17,5)
p(2,9) = p(2,9) + s(17,5)
c - - - - -
c   tlt2 phi l           Table 5   Formula 6
c
c   s(21,5) = s(17,4) * ( p1(2,1) - p5(2,1) )
c
c   p(2,5) = p(2,5) + s(21,5)
c   p(2,7) = p(2,7) + s(21,5)
c   p(2,9) = p(2,9) + s(21,5)
c - - - - -
c   t1 t2 l           Table 5   Formula 7
c
c   s(25,5) = s(17,4) * ( p1(2,2) - p5(2,2) )
c
c   p(2,5) = p(2,5) + s(25,5)
c   p(2,7) = p(2,7) + s(25,5)
c   p(2,9) = p(2,9) + s(25,5)
c - - - - -
c   phi t1 l           Table 5   Formula 5
c
c   s(33,5) = s(33,1) * p4(2) + s(33,4) * ( 1. - p1(2,1)
*   - p1(2,2) - p3(2,2,1) - p6(2) )
c
c   p(2,5) = p(2,5) + s(33,5)
c   p(2,7) = p(2,7) + s(33,5)
c   p(2,9) = p(2,9) + s(33,5)
c - - - - -
c   t2 t1 l           Table 5   Formula 6
c
c   s(37,5) = s(33,4) * ( p1(2,1) - p5(2,1) )
c
c   p(2,5) = p(2,5) + s(37,5)
c   p(2,7) = p(2,7) + s(37,5)
c   p(2,9) = p(2,9) + s(37,5)
c - - - - -
c   phi tlt2 l           Table 5   Formula 7
c
c   s(41,5) = s(33,4) * ( p1(2,2) - p5(2,2) )
c
c   p(2,5) = p(2,5) + s(41,5)
c   p(2,7) = p(2,7) + s(41,5)
c   p(2,9) = p(2,9) + s(41,5)
c - - - - -
c   star l           Table 5   Formula 8
c
c   s(65,5) = s(65,1) * p4(2) + s(65,4)
*   + s(1,4) * ( p5(2,1) + p5(2,2) + p6(2) )
*   + s(17,4) * ( p5(2,1) + p5(2,2)
*   + p3(1,2,1) + p6(2) )
*   + s(33,4) * ( p5(2,1) + p5(2,2)
*   + p3(2,2,1) + p6(2) )
c
c   p(2,6) = p(2,6) + s(65,5)

```

```

p(2,7) = p(2,7) + s(65,5)
p(2,8) = p(2,8) + s(65,5)
p(2,9) = p(2,9) + s(65,5)
c -----
ptot = p(2,1) + p(2,2) + p(2,3) + p(2,4) + p(2,5) + p(2,6)
if( abs( 1. - ptot ) .gt. .000001 ) write (*,100) ptot
100 format(' sum of DEPENDENT probabilities for 2 bursts is ',f10.7)
return
end

```

```

subroutine pd3
c
c ***** calculate state probabilities for third burst *****
c *****DEPENDENT EVENTS*****
c
  implicit real*8 (a-h, o-z)
  common p1(3,2), p3(2,2:3,3), p4(3), p5(3,2), p(6,9), p6(3),
  * p9(3,10), p10(3,10), p11(3,2), p12(2,2:3,3),
  * q1(3,2), q3(2,2:3,3), q4(3), q5(3,2), q6(3),
  * s(65,6), t(65,6), nis(2), isink(2,10)
c -----
c   pni  phi  0           Table 5   Formula 1
c
c   s(1,3) = s(1,2) * ( 1. - p1(3,1) - p1(3,2) - p4(3) - p6(3) )
c
c           p(3,1) = p(3,1) + s(1,3)
c -----
c   t3  phi  0           Table 5   Formula 2
c
c   s(2,3) = s(1,2) * ( p1(3,1) - p5(3,1) )
c
c           p(3,2) = p(3,2) + s(2,3)
c -----
c   phi  t3  0           Table 5   Formula 3
c
c   s(3,3) = s(1,2) * ( p1(3,2) - p5(3,2) )
c
c           p(3,2) = p(3,2) + s(3,3)
c -----
c   t2  pni  0           Table 5   Formula 1
c
c   s(5,3) = s(5,2) * ( 1. - p1(3,1) - p1(3,2)
  *               - p3(1,3,2) - p4(3) - p6(3) )
c
c           p(3,2) = p(3,2) + s(5,3)
c -----
c   t2t3  phi  0           Table 5   Formula 2
c
c   s(6,3) = s(5,2) * ( p1(3,1) - p5(3,1) )
c
c           p(3,2) = p(3,2) + s(6,3)
c -----
c   t2  t3  0           Table 5   Formula 3
c
c   s(7,3) = s(5,2) * ( p1(3,2) - p5(3,2) )
c
c           p(3,2) = p(3,2) + s(7,3)
c -----
c   phi  t2  0           Table 5   Formula 1
c
c   s(9,3) = s(9,2) * ( 1. - p1(3,1) - p1(3,2)
  *               - p3(2,3,2) - p4(3) - p6(3) )
c
c           p(3,2) = p(3,2) + s(9,3)
c -----

```

```

c      t3 t2 0          Table 5  Formula 2
c
c      s(10,3) = s(9,2) * ( p1(3,1) - p5(3,1) )
c
c      p(3,2) = p(3,2) + s(10,3)
c - - - - -
c      phi t2t3 0          Table 5  Formula 3
c
c      s(11,3) = s(9,2) * ( p1(3,2) - p5(3,2) )
c
c      p(3,2) = p(3,2) + s(11,3)
c - - - - -
c      t1 phi 0          Table 5  Formula 1
c
c      s(17,3) = s(17,2) * ( 1. - p1(3,1) - p1(3,2)
*      - p3(1,3,1) - p4(3) - p6(3) )
c
c      p(3,2) = p(3,2) + s(17,3)
c - - - - -
c      tit3 phi 0          Table 5  Formula 2
c
c      s(18,3) = s(17,2) * ( p1(3,1) - p5(3,1) )
c
c      p(3,2) = p(3,2) + s(18,3)
c - - - - -
c      t1 t3 0          Table 5  Formula 3
c
c      s(19,3) = s(17,2) * ( p1(3,2) - p5(3,2) )
c
c      p(3,2) = p(3,2) + s(19,3)
c - - - - -
c      tit2 phi 0          Table 5  Formula 1
c
c      s(21,3) = s(21,2) * ( 1. - p1(3,1) - p1(3,2)
*      - p3(1,3,3) - p4(3) - p6(3) )
c
c      p(3,2) = p(3,2) + s(21,3)
c - - - - -
c      tit2t3 phi 0          Table 5  Formula 2
c
c      s(22,3) = s(21,2) * ( p1(3,1) - p5(3,1) )
c
c      p(3,2) = p(3,2) + s(22,3)
c - - - - -
c      tit2 t3 0          Table 5  Formula 3
c
c      s(23,3) = s(21,2) * ( p1(3,2) - p5(3,2) )
c
c      p(3,2) = p(3,2) + s(23,3)
c - - - - -
c      t1 t2 0          Table 5  Formula 1
c
c      s(25,3) = s(25,2) * ( 1. - p1(3,1) - p1(3,2) - p3(1,3,1)
*      - p3(2,3,2) - p4(3) - p6(3) )
c

```

```

c          p(3,2) = p(3,2) + s(25,3)
c -----
c      tlt3  t2  0          Table 5   Formula 2
c
c      s(26,3) = s(25,2) * ( pl(3,1) - p5(3,1) )
c
c          p(3,2) = p(3,2) + s(26,3)
c -----
c      t1  t2t3  0          Table 5   Formula 3
c
c      s(27,3) = s(25,2) * ( pl(3,2) - p5(3,2) )
c
c          p(3,2) = p(3,2) + s(27,3)
c -----
c      phi  t1  0          Table 5   Formula 1
c
c      s(33,3) = s(33,2) * ( 1. - pl(3,1) - pl(3,2)
*          - p3(2,3,1) - p4(3) - p6(3) )
c
c          p(3,2) = p(3,2) + s(33,3)
c -----
c      t3  t1  0          Table 5   Formula 2
c
c      s(34,3) = s(33,2) * ( pl(3,1) - p5(3,1) )
c
c          p(3,2) = p(3,2) + s(34,3)
c -----
c      phi  tlt3  0          Table 5   Formula 3
c
c      s(35,3) = s(33,2) * ( pl(3,2) - p5(3,2) )
c
c          p(3,2) = p(3,2) + s(35,3)
c -----
c      t2  t1  0          Table 5   Formula 1
c
c      s(37,3) = s(37,2) * ( 1. - pl(3,1) - pl(3,2) - p3(1,3,2)
*          - p3(2,3,1) - p4(3) - p6(3) )
c
c          p(3,2) = p(3,2) + s(37,3)
c -----
c      t2t3  t1  0          Table 5   Formula 2
c
c      s(38,3) = s(37,2) * ( pl(3,1) - p5(3,1) )
c
c          p(3,2) = p(3,2) + s(38,3)
c -----
c      t2  tlt3  0          Table 5   Formula 3
c
c      s(39,3) = s(37,2) * ( pl(3,2) - p5(3,2) )
c
c          p(3,2) = p(3,2) + s(39,3)
c -----
c      pni  tlt2  0          Table 5   Formula 1
c
c      s(41,3) = s(41,2) * ( 1. - pl(3,1) - pl(3,2)

```

```

*
c                                     - p3(2,3,3) - p4(3) - p6(3) )
c
c                                     p(3,2) = p(3,2) + s(41,3)
c - - - - -
c   t3 t1t2 0                       Table 5   Formula 2
c
c   s(42,3) = s(41,2) * ( p1(3,1) - p5(3,1) )
c
c                                     p(3,2) = p(3,2) + s(42,3)
c - - - - -
c   phi t1t2t3 0                   Table 5   Formula 3
c
c   s(43,3) = s(41,2) * ( p1(3,2) - p5(3,2) )
c
c                                     p(3,2) = p(3,2) + s(43,3)
c - - - - -
c   star 0                           Table 5   Formula 4
c
c   s(65,3) = s(65,2) * q4(3)
*                                     + s(1,2) * ( p5(3,1) + p5(3,2) + p6(3) )
*                                     + s(17,2) * ( p5(3,1) + p5(3,2)
*                                     + p3(1,3,1) + p6(3) )
*                                     + s(5,2) * ( p5(3,1) + p5(3,2)
*                                     + p3(1,3,2) + p6(3) )
*                                     + s(21,2) * ( p5(3,1) + p5(3,2)
*                                     + p3(1,3,3) + p6(3) )
*                                     + s(33,2) * ( p5(3,1) + p5(3,2)
*                                     + p3(2,3,1) + p6(3) )
*                                     + s(9,2) * ( p5(3,1) + p5(3,2)
*                                     + p3(2,3,2) + p6(3) )
*                                     + s(41,2) * ( p5(3,1) + p5(3,2)
*                                     + p3(2,3,3) + p6(3) )
*                                     + s(25,2) * ( p5(3,1) + p5(3,2)
*                                     + p3(1,3,1) + p3(2,3,2) + p6(3) )
*                                     + s(37,2) * ( p5(3,1) + p5(3,2)
*                                     + p3(1,3,2) + p3(2,3,1) + p6(3) )
c
c                                     p(3,4) = p(3,4) + s(65,3)
c                                     p(3,8) = p(3,8) + s(65,3)
c                                     p(3,9) = p(3,9) + s(65,3)
c - - - - -
c   phi phi 1                       Table 5   Formula 5
c
c   s(1,6) = s(1,2) * p4(3) + s(1,5) * ( 1. - p1(3,1)
*   - p1(3,2) - p6(3) )
c
c                                     p(3,3) = p(3,3) + s(1,6)
c                                     p(3,7) = p(3,7) + s(1,6)
c                                     p(3,9) = p(3,9) + s(1,6)
c - - - - -
c   t3 pni 1                       Table 5   Formula 6
c
c   s(2,6) = s(1,5) * ( p1(3,1) - p5(3,1) )
c
c                                     p(3,5) = p(3,5) + s(2,6)

```

```

p(3,7) = p(3,7) + s(2,6)
p(3,9) = p(3,9) + s(2,6)
c - - - - -
c   phi t3 1          Table 5   Formula 7
c
s(3,6) = s(1,5) * ( pl(3,2) - p5(3,2) )
c
p(3,5) = p(3,5) + s(3,6)
p(3,7) = p(3,7) + s(3,6)
p(3,9) = p(3,9) + s(3,6)
c - - - - -
c   t2 phi 1          Table 5   Formula 5
c
s(5,6) = s(5,2) * p4(3) + s(5,5) * ( 1. - pl(3,1)
*      - pl(3,2) - p3(1,3,2) - p6(3) )
c
p(3,5) = p(3,5) + s(5,6)
p(3,7) = p(3,7) + s(5,6)
p(3,9) = p(3,9) + s(5,6)
c - - - - -
c   t2t3 phi 1        Table 5   Formula 6
c
s(6,6) = s(5,5) * ( pl(3,1) - p5(3,1) )
c
p(3,5) = p(3,5) + s(6,6)
p(3,7) = p(3,7) + s(6,6)
p(3,9) = p(3,9) + s(6,6)
c - - - - -
c   t2 t3 1           Table 5   Formula 7
c
s(7,6) = s(5,5) * ( pl(3,2) - p5(3,2) )
c
p(3,5) = p(3,5) + s(7,6)
p(3,7) = p(3,7) + s(7,6)
p(3,9) = p(3,9) + s(7,6)
c - - - - -
c   phi t2 1          Table 5   Formula 5
c
s(9,6) = s(9,2) * p4(3) + s(9,5) * ( 1. - pl(3,1)
*      - pl(3,2) - p3(2,3,2) - p6(3) )
c
p(3,5) = p(3,5) + s(9,6)
p(3,7) = p(3,7) + s(9,6)
p(3,9) = p(3,9) + s(9,6)
c - - - - -
c   t3 t2 1           Table 5   Formula 6
c
s(10,6) = s(9,5) * ( pl(3,1) - p5(3,1) )
c
p(3,5) = p(3,5) + s(10,6)
p(3,7) = p(3,7) + s(10,6)
p(3,9) = p(3,9) + s(10,6)
c - - - - -
c   phi t2t3 1        Table 5   Formula 7
c

```

```

c      s(11,6) = s(9,5) * ( p1(3,2) - p5(3,2) )
c
c      p(3,5) = p(3,5) + s(11,6)
c      p(3,7) = p(3,7) + s(11,6)
c      p(3,9) = p(3,9) + s(11,6)
c -----
c      t1  pni  1          Table 5   Formula 5
c
c      s(17,6) = s(17,2) * p4(3) + s(17,5) * ( 1. - p1(3,1)
*      - p1(3,2) - p3(1,3,1) - p6(3) )
c
c      p(3,5) = p(3,5) + s(17,6)
c      p(3,7) = p(3,7) + s(17,6)
c      p(3,9) = p(3,9) + s(17,6)
c -----
c      t1t3  phi  1          Table 5   Formula 6
c
c      s(18,6) = s(17,5) * ( p1(3,1) - p5(3,1) )
c
c      p(3,5) = p(3,5) + s(18,6)
c      p(3,7) = p(3,7) + s(18,6)
c      p(3,9) = p(3,9) + s(18,6)
c -----
c      t1  t3  1          Table 5   Formula 7
c
c      s(19,6) = s(17,5) * ( p1(3,2) - p5(3,2) )
c
c      p(3,5) = p(3,5) + s(19,6)
c      p(3,7) = p(3,7) + s(19,6)
c      p(3,9) = p(3,9) + s(19,6)
c -----
c      t1t2  pni  1          Table 5   Formula 5
c
c      s(21,6) = s(21,2) * p4(3) + s(21,5) * ( 1. - p1(3,1)
*      - p1(3,2) - p3(1,3,3) - p6(3) )
c
c      p(3,5) = p(3,5) + s(21,6)
c      p(3,7) = p(3,7) + s(21,6)
c      p(3,9) = p(3,9) + s(21,6)
c -----
c      t1t2t3  pni  1          Table 5   Formula 6
c
c      s(22,6) = s(21,5) * ( p1(3,1) - p5(3,1) )
c
c      p(3,5) = p(3,5) + s(22,6)
c      p(3,7) = p(3,7) + s(22,6)
c      p(3,9) = p(3,9) + s(22,6)
c -----
c      t1t2  t3  1          Table 5   Formula 7
c
c      s(23,6) = s(21,5) * ( p1(3,2) - p5(3,2) )
c
c      p(3,5) = p(3,5) + s(23,6)
c      p(3,7) = p(3,7) + s(23,6)
c      p(3,9) = p(3,9) + s(23,6)

```

```

c -----
c      t1 t2 1          Table 5   Formula 5
c
c      s(25,6) = s(25,2) * p4(3) + s(25,5) * ( 1. - p1(3,1)
*          - p1(3,2) - p3(1,3,1) - p3(2,3,2) - p6(3) )
c
c          p(3,5) = p(3,5) + s(25,6)
c          p(3,7) = p(3,7) + s(25,6)
c          p(3,9) = p(3,9) + s(25,6)
c -----
c      t1t3 t2 1          Table 5   Formula 6
c
c      s(26,6) = s(25,5) * ( p1(3,1) - p5(3,1) )
c
c          p(3,5) = p(3,5) + s(26,6)
c          p(3,7) = p(3,7) + s(26,6)
c          p(3,9) = p(3,9) + s(26,6)
c -----
c      t1 t2t3 1          Table 5   Formula 7
c
c      s(27,6) = s(25,5) * ( p1(3,2) - p5(3,2) )
c
c          p(3,5) = p(3,5) + s(27,6)
c          p(3,7) = p(3,7) + s(27,6)
c          p(3,9) = p(3,9) + s(27,6)
c -----
c      phi t1 1          Table 5   Formula 5
c
c      s(33,6) = s(33,2) * p4(3) + s(33,5) * ( 1. - p1(3,1)
*          - p1(3,2) - p3(2,3,1) - p6(3) )
c
c          p(3,5) = p(3,5) + s(33,6)
c          p(3,7) = p(3,7) + s(33,6)
c          p(3,9) = p(3,9) + s(33,6)
c -----
c      t3 t1 1          Table 5   Formula 6
c
c      s(34,6) = s(33,5) * ( p1(3,1) - p5(3,1) )
c
c          p(3,5) = p(3,5) + s(34,6)
c          p(3,7) = p(3,7) + s(34,6)
c          p(3,9) = p(3,9) + s(34,6)
c -----
c      phi t1t3 1          Table 5   Formula 7
c
c      s(35,6) = s(33,5) * ( p1(3,2) - p5(3,2) )
c
c          p(3,5) = p(3,5) + s(35,6)
c          p(3,7) = p(3,7) + s(35,6)
c          p(3,9) = p(3,9) + s(35,6)
c -----
c      t2 t1 1          Table 5   Formula 5
c
c      s(37,6) = s(37,2) * p4(3) + s(37,5) * ( 1. - p1(3,1)
*          - p1(3,2) - p3(1,3,2) - p3(2,3,1) - p6(3) )

```

```

c
      p(3,5) = p(3,5) + s(37,6)
      p(3,7) = p(3,7) + s(37,6)
      p(3,9) = p(3,9) + s(37,6)
c - - - - -
c      t2t3 t1 1      Table 5      Formula 6
c
      s(38,6) = s(37,5) * ( p1(3,1) - p5(3,1) )
c
      p(3,5) = p(3,5) + s(38,6)
      p(3,7) = p(3,7) + s(38,6)
      p(3,9) = p(3,9) + s(38,6)
c - - - - -
c      t2 t1t3 1      Table 5      Formula 7
c
      s(39,6) = s(37,5) * ( p1(3,2) - p5(3,2) )
c
      p(3,5) = p(3,5) + s(39,6)
      p(3,7) = p(3,7) + s(39,6)
      p(3,9) = p(3,9) + s(39,6)
c - - - - -
c      phi t1t2 1      Table 5      Formula 5
c
      s(41,6) = s(41,2) * p4(3) + s(41,5) * ( 1. - p1(3,1)
*      - p1(3,2) - p3(2,3,3) - p6(3) )
c
      p(3,5) = p(3,5) + s(41,6)
      p(3,7) = p(3,7) + s(41,6)
      p(3,9) = p(3,9) + s(41,6)
c - - - - -
c      t3 t1t2 1      Table 5      Formula 6
c
      s(42,6) = s(41,5) * ( p1(3,1) - p5(3,1) )
c
      p(3,5) = p(3,5) + s(42,6)
      p(3,7) = p(3,7) + s(42,6)
      p(3,9) = p(3,9) + s(42,6)
c - - - - -
c      phi t1t2t3 1      Table 5      Formula 7
c
      s(43,6) = s(41,5) * ( p1(3,2) - p5(3,2) )
c
      p(3,5) = p(3,5) + s(43,6)
      p(3,7) = p(3,7) + s(43,6)
      p(3,9) = p(3,9) + s(43,6)
c - - - - -
c      star 1      Table 5      Formula 8
c
      s(65,6) = s(65,2) * p4(3) + s(65,5)
*      + s(1,5) * ( p5(3,1) + p5(3,2) + p6(3) )
*      + s(17,5) * ( p5(3,1) + p5(3,2)
*      + p3(1,3,1) + p6(3) )
*      + s(5,5) * ( p5(3,1) + p5(3,2)
*      + p3(1,3,2) + p6(3) )
*      + s(21,5) * ( p5(3,1) + p5(3,2)

```

```

*          + p3(1,3,3) + p6(3) )
*      + s(33,5) * ( p5(3,1) + p5(3,2)
*          + p3(2,3,1) + p6(3) )
*      + s(9,5) * ( p5(3,1) + p5(3,2)
*          + p3(2,3,2) + p6(3) )
*      + s(41,5) * ( p5(3,1) + p5(3,2)
*          + p3(2,3,3) + p6(3) )
*      + s(25,5) * ( p5(3,1) + p5(3,2) + p3(1,3,1)
*          + p3(2,3,2) + p6(3) )
*      + s(37,5) * ( p5(3,1) + p5(3,2) + p3(1,3,2)
*          + p3(2,3,1) + p6(3) )
c
      p(3,6) = p(3,6) + s(65,6)
      p(3,7) = p(3,7) + s(65,6)
      p(3,8) = p(3,8) + s(65,6)
      p(3,9) = p(3,9) + s(65,6)
c -----
      ptot = p(3,1) + p(3,2) + p(3,3) + p(3,4) + p(3,5) + p(3,6)
      if( abs( 1. - ptot ) .gt. .000001 ) write (*,100) ptot
100 format(' sum of DEPENDENT probabilities for 3 bursts is ',f10.7)
      return
      end

```

```

subroutine pil
c
c ***** calculate state probabilities for first burst *****
c *****INDEPENDENT EVENTS*****
c
  implicit real*8 (a-n, o-z)
  common pl(3,2), p3(2,2:3,3), p4(3), p5(3,2), p(6,9), p6(3),
  * p9(3,10), pl0(3,10), pl1(3,2), pl2(2,2:3,3),
  * q1(3,2), q3(2,2:3,3), q4(3), q5(3,2), q6(3),
  * s(65,6), t(65,6), nis(2), isink(2,10)
c -----
  qlq2 = q1(1,1) * q1(1,2) * q6(1)
  plq2 = ( pl(1,1) - p5(1,1) ) * q1(1,2) * q6(1)
  p2q1 = ( pl(1,2) - p5(1,2) ) * q1(1,1) * q6(1)
  plp2 = ( pl(1,1) - p5(1,1) ) * ( pl(1,2) - p5(1,2) ) * q6(1)
c -----
c   pni   phi   0           Table 6   Formula 1
c
  t(1,1) = qlq2 * q4(1)
c
  p(1,1) = p(1,1) + t(1,1)
c -----
c   t1   phi   0           Table 6   Formula 2
c
  t(17,1) = plq2 * q4(1)
c
  p(1,2) = p(1,2) + t(17,1)
c -----
c   pni   t1   0           Table 6   Formula 3
c
  t(33,1) = p2q1 * q4(1)
c
  p(1,2) = p(1,2) + t(33,1)
c -----
c   t1   t1   0           Table 6   Formula 4
c
  t(49,1) = plp2 * q4(1)
c
  p(1,2) = p(1,2) + t(49,1)
c -----
c   *   0           Table 6   Formula 5
c
  t(65,1) = q4(1) * ( 1. - q5(1,1) * q5(1,2) * q6(1) )
c
  p(1,4) = p(1,4) + t(65,1)
  p(1,8) = p(1,8) + t(65,1)
  p(1,9) = p(1,9) + t(65,1)
c -----
c   pni   pni   1           Table 6   Formula 6
c
  t(1,4) = qlq2 * p4(1)
c
  p(1,3) = p(1,3) + t(1,4)
  p(1,7) = p(1,7) + t(1,4)
  p(1,9) = p(1,9) + t(1,4)

```

```

c -----
c      t1 phi 1          Table 6      Formula 7
c
c      t(17,4) = p1q2 * p4(1)
c
c              p(1,5) = p(1,5) + t(17,4)
c              p(1,7) = p(1,7) + t(17,4)
c              p(1,9) = p(1,9) + t(17,4)
c -----
c      phi t1 1          Table 6      Formula 8
c
c      t(33,4) = p2q1 * p4(1)
c
c              p(1,5) = p(1,5) + t(33,4)
c              p(1,7) = p(1,7) + t(33,4)
c              p(1,9) = p(1,9) + t(33,4)
c -----
c      t1 t1 1          Table 6      Formula 9
c
c      t(49,4) = p1p2 * p4(1)
c
c              p(1,5) = p(1,5) + t(49,4)
c              p(1,7) = p(1,7) + t(49,4)
c              p(1,9) = p(1,9) + t(49,4)
c -----
c      * 1              Table 6      Formula 10
c
c      t(65,4) = p4(1) * ( 1. - q5(1,1) * q5(1,2) * q6(1) )
c
c              p(1,6) = p(1,6) + t(65,4)
c              p(1,7) = p(1,7) + t(65,4)
c              p(1,8) = p(1,8) + t(65,4)
c              p(1,9) = p(1,9) + t(65,4)
c -----
c      ptot = p(1,1) + p(1,2) + p(1,3) + p(1,4) + p(1,5) + p(1,6)
c      if ( abs( 1. - ptot ) .gt. .000001 )write(*,100)ptot
100 format(' sum of INDEPENDENT probabilities for 1 burst is ',f10.7)
c      return
c      end

```

```

subroutine pi2
c
c ***** calculate state probabilities for second burst *****
c *****INDEPENDENT EVENTS*****
c
c      implicit real*8 (a-h, o-z)
c      common pl(3,2), p3(2,2:3,3), p4(3), p5(3,2), p(6,9), p6(3),
c      * p9(3,10), pl0(3,10), pl1(3,2), pl2(2,2:3,3),
c      * ql(3,2), q3(2,2:3,3), q4(3), q5(3,2), q6(3),
c      * s(65,6), t(65,6), nis(2), isink(2,10)
c      -----
c      qlq2 = ql(2,1) * ql(2,2) * q6(2)
c      plq2 = ( pl(2,1) - p5(2,1) ) * ql(2,2) * q6(2)
c      p2q1 = ( pl(2,2) - p5(2,2) ) * ql(2,1) * q6(2)
c      plp2 = ( pl(2,1) - p5(2,1) ) * ( pl(2,2) - p5(2,2) ) * q6(2)
c      -----
c      phi phi 0          Table 6      Formula 1
c
c      t(1,2) = t(1,1) * qlq2 * q4(2)
c
c      p(2,1) = p(2,1) + t(1,2)
c      -----
c      t2 phi 0          Table 6      Formula 2
c
c      t(5,2) = t(1,1) * plq2 * q4(2)
c
c      p(2,2) = p(2,2) + t(5,2)
c      -----
c      phi t2 0          Table 6      Formula 3
c
c      t(9,2) = t(1,1) * p2q1 * q4(2)
c
c      p(2,2) = p(2,2) + t(9,2)
c      -----
c      t2 t2 0          Table 6      Formula 4
c
c      t(13,2) = t(1,1) * plp2 * q4(2)
c
c      p(2,2) = p(2,2) + t(13,2)
c      -----
c      t1 phi 0          Table 6      Formula 1
c
c      t(17,2) = t(17,1) * qlq2 * q3(1,2,1) * q4(2)
c
c      p(2,2) = p(2,2) + t(17,2)
c      -----
c      t1t2 phi 0          Table 6      Formula 2
c
c      t(21,2) = t(17,1) * plq2 * q3(1,2,1) * q4(2)
c
c      p(2,2) = p(2,2) + t(21,2)
c      -----
c      t1 t2 0          Table 6      Formula 3
c
c      t(25,2) = t(17,1) * p2q1 * q3(1,2,1) * q4(2)

```

```

c
c      p(2,2) = p(2,2) + t(25,2)
c - - - - -
c      tlt2 t2 0      Table 6      Formula 4
c
c      t(29,2) = t(17,1) * plp2 * q3(1,2,1) * q4(2)
c
c      p(2,2) = p(2,2) + t(29,2)
c - - - - -
c      phi t1 0      Table 6      Formula 1
c
c      t(33,2) = t(33,1) * qlq2 * q3(2,2,1) * q4(2)
c
c      p(2,2) = p(2,2) + t(33,2)
c - - - - -
c      t2 t1 0      Table 6      Formula 2
c
c      t(37,2) = t(33,1) * plq2 * q3(2,2,1) * q4(2)
c
c      p(2,2) = p(2,2) + t(37,2)
c - - - - -
c      pni tlt2 0      Table 6      Formula 3
c
c      t(41,2) = t(33,1) * p2q1 * q3(2,2,1) * q4(2)
c
c      p(2,2) = p(2,2) + t(41,2)
c - - - - -
c      t2 tlt2 0      Table 6      Formula 4
c
c      t(45,2) = t(33,1) * plp2 * q3(2,2,1) * q4(2)
c
c      p(2,2) = p(2,2) + t(45,2)
c - - - - -
c      t1 t1 0      Table 6      Formula 1
c
c      t(49,2) = t(49,1) * qlq2 * q3(1,2,1) * q3(2,2,1) * q4(2)
c
c      p(2,2) = p(2,2) + t(49,2)
c - - - - -
c      tlt2 t1 0      Table 6      Formula 2
c
c      t(53,2) = t(49,1) * plq2 * q3(1,2,1) * q3(2,2,1) * q4(2)
c
c      p(2,2) = p(2,2) + t(53,2)
c - - - - -
c      t1 tlt2 0      Table 6      Formula 3
c
c      t(57,2) = t(49,1) * p2q1 * q3(1,2,1) * q3(2,2,1) * q4(2)
c
c      p(2,2) = p(2,2) + t(57,2)
c - - - - -
c      tlt2 tlt2 0      Table 6      Formula 4
c
c      t(61,2) = t(49,1) * plp2 * q3(1,2,1) * q3(2,2,1) * q4(2)
c

```

```

c -----
c      p(2,2) = p(2,2) + t(61,2)
c      * 0      Table 6      Formula 5
c
c      t(65,2) = q4(2) * ( t(65,1)
*      + t(1,1) * ( 1. - q5(2,1) * q5(2,2) * q6(2) )
*      + t(17,1) * ( 1. - q5(2,1) * q5(2,2) * q3(1,2,1) * q6(2) )
*      + t(33,1) * ( 1. - q5(2,1) * q5(2,2) * q3(2,2,1) * q6(2) )
*      + t(49,1) * ( 1. - q5(2,1) * q5(2,2)
*      * q3(1,2,1) * q3(2,2,1) * q6(2) ) )
c
c      p(2,4) = p(2,4) + t(65,2)
c      p(2,8) = p(2,8) + t(65,2)
c      p(2,9) = p(2,9) + t(65,2)
c -----
c      phi phi 1      Table 6      Formula 6
c
c      t(1,5) = q1q2 * ( t(1,1) * p4(2) + t(1,4) )
c
c      p(2,3) = p(2,3) + t(1,5)
c      p(2,7) = p(2,7) + t(1,5)
c      p(2,9) = p(2,9) + t(1,5)
c -----
c      t2 phi 1      Table 6      Formula 7
c
c      t(5,5) = p1q2 * ( t(1,1) * p4(2) + t(1,4) )
c
c      p(2,5) = p(2,5) + t(5,5)
c      p(2,7) = p(2,7) + t(5,5)
c      p(2,9) = p(2,9) + t(5,5)
c -----
c      phi t2 1      Table 6      Formula 8
c
c      t(9,5) = p2q1 * ( t(1,1) * p4(2) + t(1,4) )
c
c      p(2,5) = p(2,5) + t(9,5)
c      p(2,7) = p(2,7) + t(9,5)
c      p(2,9) = p(2,9) + t(9,5)
c -----
c      t2 t2 1      Table 6      Formula 9
c
c      t(13,5) = p1p2 * ( t(1,1) * p4(2) + t(1,4) )
c
c      p(2,5) = p(2,5) + t(13,5)
c      p(2,7) = p(2,7) + t(13,5)
c      p(2,9) = p(2,9) + t(13,5)
c -----
c      t1 phi 1      Table 6      Formula 6
c
c      t(17,5) = q1q2 * q3(1,2,1) * ( t(17,1) * p4(2) + t(17,4) )
c
c      p(2,5) = p(2,5) + t(17,5)
c      p(2,7) = p(2,7) + t(17,5)
c      p(2,9) = p(2,9) + t(17,5)
c -----

```

```

c      tlt2 phi 1      Table 6      Formula 7
c
c      t(21,5) = plq2 * q3(1,2,1) * ( t(17,1) * p4(2) + t(17,4) )
c
c      p(2,5) = p(2,5) + t(21,5)
c      p(2,7) = p(2,7) + t(21,5)
c      p(2,9) = p(2,9) + t(21,5)
c -----
c      t1 t2 1      Table 6      Formula 8
c
c      t(25,5) = p2q1 * q3(1,2,1) * ( t(17,1) * p4(2) + t(17,4) )
c
c      p(2,5) = p(2,5) + t(25,5)
c      p(2,7) = p(2,7) + t(25,5)
c      p(2,9) = p(2,9) + t(25,5)
c -----
c      tlt2 t2 1      Table 6      Formula 9
c
c      t(29,5) = plp2 * q3(1,2,1) * ( t(17,1) * p4(2) + t(17,4) )
c
c      p(2,5) = p(2,5) + t(29,5)
c      p(2,7) = p(2,7) + t(29,5)
c      p(2,9) = p(2,9) + t(29,5)
c -----
c      phi t1 1      Table 6      Formula 6
c
c      t(33,5) = qlq2 * q3(2,2,1) * ( t(33,1) * p4(2) + t(33,4) )
c
c      p(2,5) = p(2,5) + t(33,5)
c      p(2,7) = p(2,7) + t(33,5)
c      p(2,9) = p(2,9) + t(33,5)
c -----
c      t2 t1 1      Table 6      Formula 7
c
c      t(37,5) = plq2 * q3(2,2,1) * ( t(33,1) * p4(2) + t(33,4) )
c
c      p(2,5) = p(2,5) + t(37,5)
c      p(2,7) = p(2,7) + t(37,5)
c      p(2,9) = p(2,9) + t(37,5)
c -----
c      phi tlt2 1      Table 6      Formula 8
c
c      t(41,5) = p2q1 * q3(2,2,1) * ( t(33,1) * p4(2) + t(33,4) )
c
c      p(2,5) = p(2,5) + t(41,5)
c      p(2,7) = p(2,7) + t(41,5)
c      p(2,9) = p(2,9) + t(41,5)
c -----
c      t2 tlt2 1      Table 6      Formula 9
c
c      t(45,5) = plp2 * q3(2,2,1) * ( t(33,1) * p4(2) + t(33,4) )
c
c      p(2,5) = p(2,5) + t(45,5)
c      p(2,7) = p(2,7) + t(45,5)
c      p(2,9) = p(2,9) + t(45,5)

```

```

c - - - - -
c   t1 t1 1          Table 6   Formula 6
c
c   t(49,5) = q1q2 * q3(1,2,1) * q3(2,2,1)
*               * ( t(49,1) * p4(2) + t(49,4) )
c
c           p(2,5) = p(2,5) + t(49,5)
c           p(2,7) = p(2,7) + t(49,5)
c           p(2,9) = p(2,9) + t(49,5)
c - - - - -
c   t1t2 t1 1          Table 6   Formula 7
c
c   t(53,5) = p1q2 * q3(1,2,1) * q3(2,2,1)
*               * ( t(49,1) * p4(2) + t(49,4) )
c
c           p(2,5) = p(2,5) + t(53,5)
c           p(2,7) = p(2,7) + t(53,5)
c           p(2,9) = p(2,9) + t(53,5)
c - - - - -
c   t1 t1t2 1          Table 6   Formula 8
c
c   t(57,5) = p2q1 * q3(1,2,1) * q3(2,2,1)
*               * ( t(49,1) * p4(2) + t(49,4) )
c
c           p(2,5) = p(2,5) + t(57,5)
c           p(2,7) = p(2,7) + t(57,5)
c           p(2,9) = p(2,9) + t(57,5)
c - - - - -
c   t1t2 t1t2 1          Table 6   Formula 9
c
c   t(61,5) = p1p2 * q3(1,2,1) * q3(2,2,1)
*               * ( t(49,1) * p4(2) + t(49,4) )
c
c           p(2,5) = p(2,5) + t(61,5)
c           p(2,7) = p(2,7) + t(61,5)
c           p(2,9) = p(2,9) + t(61,5)
c - - - - -
c   * 1          Table 6   Formula 10
c
c   t(65,5) = t(65,1) * p4(2) + t(65,4)
*           + ( t(1,1) * p4(2) + t(1,4) )
*           * ( 1. - q5(2,1) * q5(2,2) * q6(2) )
*           + ( t(17,1) * p4(2) + t(17,4) )
*           * ( 1. - q5(2,1) * q5(2,2) * q3(1,2,1) * q6(2) )
*           + ( t(33,1) * p4(2) + t(33,4) )
*           * ( 1. - q5(2,1) * q5(2,2) * q3(2,2,1) * q6(2) )
*           + ( t(49,1) * p4(2) + t(49,4) )
*           * ( 1. - q5(2,1) * q5(2,2) * q3(1,2,1) * q3(2,2,1) * q6(2) )
c
c           p(2,6) = p(2,6) + t(65,5)
c           p(2,7) = p(2,7) + t(65,5)
c           p(2,8) = p(2,8) + t(65,5)
c           p(2,9) = p(2,9) + t(65,5)
c - - - - -
c   ptot = p(2,1) + p(2,2) + p(2,3) + p(2,4) + p(2,5) + p(2,6)

```

```
      if( abs( 1. - ptot ) .gt. .000001 ) write (*,100) ptot
100 format(' sum of INDEPENDENT probabilities for 2 bursts is ',f10.7)
      return
end
```

```

subroutine pi3
c
c ***** calculate state probabilities for third burst *****
c *****INDEPENDENT EVENTS*****
c
c      implicit real*8 (a-h, o-z)
c      common pl(3,2), p3(2,2:3,3), p4(3), p5(3,2), p(6,9), p6(3),
c      * p9(3,10), pl0(3,10), pl1(3,2), pl2(2,2:3,3),
c      * q1(3,2), q3(2,2:3,3), q4(3), q5(3,2), q6(3),
c      * s(65,6), t(65,6), nis(2), isink(2,10)
c
c      -----
c      qlq2 = q1(3,1) * q1(3,2) * q6(3)
c      plq2 = ( pl(3,1) - p5(3,1) ) * q1(3,2) * q6(3)
c      p2q1 = ( pl(3,2) - p5(3,2) ) * q1(3,1) * q6(3)
c      plp2 = ( pl(3,1) - p5(3,1) ) * ( pl(3,2) - p5(3,2) ) * q6(3)
c      q5q6 = q5(3,1) * q5(3,2) * q6(3)
c
c      -----
c      phi phi 0          Table 6      Formula 1
c
c      t(1,3) = t(1,2) * qlq2 * q4(3)
c
c      p(3,1) = p(3,1) + t(1,3)
c
c      -----
c      t3 phi 0          Table 6      Formula 2
c
c      t(2,3) = t(1,2) * plq2 * q4(3)
c
c      p(3,2) = p(3,2) + t(2,3)
c
c      -----
c      phi t3 0          Table 6      Formula 3
c
c      t(3,3) = t(1,2) * p2q1 * q4(3)
c
c      p(3,2) = p(3,2) + t(3,3)
c
c      -----
c      t3 t3 0          Table 6      Formula 4
c
c      t(4,3) = t(1,2) * plp2 * q4(3)
c
c      p(3,2) = p(3,2) + t(4,3)
c
c      -----
c      t2 phi 0          Table 6      Formula 1
c
c      t(5,3) = t(5,2) * qlq2 * q4(3) * q3(1,3,2)
c
c      p(3,2) = p(3,2) + t(5,3)
c
c      -----
c      t2t3 phi 0          Table 6      Formula 2
c
c      t(6,3) = t(5,2) * plq2 * q4(3) * q3(1,3,2)
c
c      p(3,2) = p(3,2) + t(6,3)
c
c      -----
c      t2 t3 0          Table 6      Formula 3
c

```

```

c       $t(7,3) = t(5,2) * p2q1 * q4(3) * q3(1,3,2)$ 
c
c       $p(3,2) = p(3,2) + t(7,3)$ 
c -----
c      t2t3  t3  0      Table 6      Formula 4
c
c       $t(8,3) = t(5,2) * plp2 * q4(3) * q3(1,3,2)$ 
c
c       $p(3,2) = p(3,2) + t(8,3)$ 
c -----
c      phi  t2  0      Table 6      Formula 1
c
c       $t(9,3) = t(9,2) * qlq2 * q4(3) * q3(2,3,2)$ 
c
c       $p(3,2) = p(3,2) + t(9,3)$ 
c -----
c      t3  t2  0      Table 6      Formula 2
c
c       $t(10,3) = t(9,2) * plq2 * q4(3) * q3(2,3,2)$ 
c
c       $p(3,2) = p(3,2) + t(10,3)$ 
c -----
c      phi  t2t3  0      Table 6      Formula 3
c
c       $t(11,3) = t(9,2) * p2q1 * q4(3) * q3(2,3,2)$ 
c
c       $p(3,2) = p(3,2) + t(11,3)$ 
c -----
c      t3  t2t3  0      Table 6      Formula 4
c
c       $t(12,3) = t(9,2) * plp2 * q4(3) * q3(2,3,2)$ 
c
c       $p(3,2) = p(3,2) + t(12,3)$ 
c -----
c      t2  t2  0      Table 6      Formula 1
c
c       $t(13,3) = t(13,2) * qlq2 * q4(3) * q3(1,3,2) * q3(2,3,2)$ 
c
c       $p(3,2) = p(3,2) + t(13,3)$ 
c -----
c      t2t3  t2  0      Table 6      Formula 2
c
c       $t(14,3) = t(13,2) * plq2 * q4(3) * q3(1,3,2) * q3(2,3,2)$ 
c
c       $p(3,2) = p(3,2) + t(14,3)$ 
c -----
c      t2  t2t3  0      Table 6      Formula 3
c
c       $t(15,3) = t(13,2) * p2q1 * q4(3) * q3(1,3,2) * q3(2,3,2)$ 
c
c       $p(3,2) = p(3,2) + t(15,3)$ 
c -----
c      t2t3  t2t3  0      Table 6      Formula 4
c
c       $t(16,3) = t(13,2) * plp2 * q4(3) * q3(1,3,2) * q3(2,3,2)$ 

```

```

c
c      p(3,2) = p(3,2) + t(16,3)
c -----
c      t1  phi  0      Table 6      Formula 1
c
c      t(17,3) = t(17,2) * q1q2 * q4(3) * q3(1,3,1)
c
c      p(3,2) = p(3,2) + t(17,3)
c -----
c      t1t3  phi  0      Table 6      Formula 2
c
c      t(18,3) = t(17,2) * p1q2 * q4(3) * q3(1,3,1)
c
c      p(3,2) = p(3,2) + t(18,3)
c -----
c      t1  t3  0      Table 6      Formula 3
c
c      t(19,3) = t(17,2) * p2q1 * q4(3) * q3(1,3,1)
c
c      p(3,2) = p(3,2) + t(19,3)
c -----
c      t1t3  t3  0      Table 6      Formula 4
c
c      t(20,3) = t(17,2) * p1p2 * q4(3) * q3(1,3,1)
c
c      p(3,2) = p(3,2) + t(20,3)
c -----
c      t1t2  phi  0      Table 6      Formula 1
c
c      t(21,3) = t(21,2) * q1q2 * q4(3) * q3(1,3,3)
c
c      p(3,2) = p(3,2) + t(21,3)
c -----
c      t1t2t3  phi  0      Table 6      Formula 2
c
c      t(22,3) = t(21,2) * p1q2 * q4(3) * q3(1,3,3)
c
c      p(3,2) = p(3,2) + t(22,3)
c -----
c      t1t2  t3  0      Table 6      Formula 3
c
c      t(23,3) = t(21,2) * p2q1 * q4(3) * q3(1,3,3)
c
c      p(3,2) = p(3,2) + t(23,3)
c -----
c      t1t2t3  t3  0      Table 6      Formula 4
c
c      t(24,3) = t(21,2) * p1p2 * q4(3) * q3(1,3,3)
c
c      p(3,2) = p(3,2) + t(24,3)
c -----
c      t1  t2  0      Table 6      Formula 1
c
c      t(25,3) = t(25,2) * q1q2 * q4(3) * q3(1,3,1) * q3(2,3,2)
c

```

$$p(3,2) = p(3,2) + t(25,3)$$
c -----
c t1t3 t2 0 Table 6 Formula 2
c

$$t(26,3) = t(25,2) * p1q2 * q4(3) * q3(1,3,1) * q3(2,3,2)$$
c

$$p(3,2) = p(3,2) + t(26,3)$$
c -----
c t1 t2t3 0 Table 6 Formula 3
c

$$t(27,3) = t(25,2) * p2q1 * q4(3) * q3(1,3,1) * q3(2,3,2)$$
c

$$p(3,2) = p(3,2) + t(27,3)$$
c -----
c t1t3 t2t3 0 Table 6 Formula 4
c

$$t(28,3) = t(25,2) * p1p2 * q4(3) * q3(1,3,1) * q3(2,3,2)$$
c

$$p(3,2) = p(3,2) + t(28,3)$$
c -----
c t1t2 t2 0 Table 6 Formula 1
c

$$t(29,3) = t(29,2) * q1q2 * q4(3) * q3(1,3,3) * q3(2,3,2)$$
c

$$p(3,2) = p(3,2) + t(29,3)$$
c -----
c t1t2t3 t2 0 Table 6 Formula 2
c

$$t(30,3) = t(29,2) * p1q2 * q4(3) * q3(1,3,3) * q3(2,3,2)$$
c

$$p(3,2) = p(3,2) + t(30,3)$$
c -----
c t1t2 t2t3 0 Table 6 Formula 3
c

$$t(31,3) = t(29,2) * p2q1 * q4(3) * q3(1,3,3) * q3(2,3,2)$$
c

$$p(3,2) = p(3,2) + t(31,3)$$
c -----
c t1t2t3 t2t3 0 Table 6 Formula 4
c

$$t(32,3) = t(29,2) * p1p2 * q4(3) * q3(1,3,3) * q3(2,3,2)$$
c

$$p(3,2) = p(3,2) + t(32,3)$$
c -----
c phi t1 0 Table 6 Formula 1
c

$$t(33,3) = t(33,2) * q1q2 * q4(3) * q3(2,3,1)$$
c

$$p(3,2) = p(3,2) + t(33,3)$$
c -----
c t3 t1 0 Table 6 Formula 2
c

$$t(34,3) = t(33,2) * p1q2 * q4(3) * q3(2,3,1)$$
c

$$p(3,2) = p(3,2) + t(34,3)$$

```

c -----
c   phi  tlt3  0          Table 6      Formula 3
c
c   t(35,3) = t(35,2) * p2q1 * q4(3) * q3(2,3,1)
c
c           p(3,2) = p(3,2) + t(35,3)
c -----
c   t3  tlt3  0          Table 6      Formula 4
c
c   t(36,3) = t(33,2) * plp2 * q4(3) * q3(2,3,1)
c
c           p(3,2) = p(3,2) + t(36,3)
c -----
c   t2  t1  0          Table 6      Formula 1
c
c   t(37,3) = t(37,2) * qlq2 * q4(3) * q3(1,3,2) * q3(2,3,1)
c
c           p(3,2) = p(3,2) + t(37,3)
c -----
c   t2t3  t1  0          Table 6      Formula 2
c
c   t(38,3) = t(37,2) * plq2 * q4(3) * q3(1,3,2) * q3(2,3,1)
c
c           p(3,2) = p(3,2) + t(38,3)
c -----
c   t2  tlt3  0          Table 6      Formula 3
c
c   t(39,3) = t(37,2) * p2q1 * q4(3) * q3(1,3,2) * q3(2,3,1)
c
c           p(3,2) = p(3,2) + t(39,3)
c -----
c   t2t3  tlt3  0          Table 6      Formula 4
c
c   t(40,3) = t(37,2) * plp2 * q4(3) * q3(1,3,2) * q3(2,3,1)
c
c           p(3,2) = p(3,2) + t(40,3)
c -----
c   phi  tlt2  0          Table 6      Formula 1
c
c   t(41,3) = t(41,2) * qlq2 * q4(3) * q3(2,3,3)
c
c           p(3,2) = p(3,2) + t(41,3)
c -----
c   t3  tlt2  0          Table 6      Formula 2
c
c   t(42,3) = t(41,2) * plq2 * q4(3) * q3(2,3,3)
c
c           p(3,2) = p(3,2) + t(42,3)
c -----
c   phi  tlt2t3  0          Table 6      Formula 3
c
c   t(43,3) = t(41,2) * p2q1 * q4(3) * q3(2,3,3)
c
c           p(3,2) = p(3,2) + t(43,3)
c -----

```

```

c      t3 tlt2t3 0      Table 6      Formula 4
c
c      t(44,3) = t(41,2) * p1p2 * q4(3) * q3(2,3,3)
c
c      p(3,2) = p(3,2) + t(44,3)
c - - - - -
c      t2 tlt2 0      Table 6      Formula 1
c
c      t(45,3) = t(45,2) * q1q2 * q4(3) * q3(1,3,2) * q3(2,3,3)
c
c      p(3,2) = p(3,2) + t(45,3)
c - - - - -
c      t2t3 tlt2 0      Table 6      Formula 2
c
c      t(46,3) = t(45,2) * p1q2 * q4(3) * q3(1,3,2) * q3(2,3,3)
c
c      p(3,2) = p(3,2) + t(46,3)
c - - - - -
c      t2 tlt2t3 0      Table 6      Formula 3
c
c      t(47,3) = t(45,2) * p2q1 * q4(3) * q3(1,3,2) * q3(2,3,3)
c
c      p(3,2) = p(3,2) + t(47,3)
c - - - - -
c      t2t3 tlt2t3 0      Table 6      Formula 4
c
c      t(48,3) = t(45,2) * p1p2 * q4(3) * q3(1,3,2) * q3(2,3,3)
c
c      p(3,2) = p(3,2) + t(48,3)
c - - - - -
c      t1 t1 0      Table 6      Formula 1
c
c      t(49,3) = t(49,2) * q1q2 * q4(3) * q3(1,3,1) * q3(2,3,1)
c
c      p(3,2) = p(3,2) + t(49,3)
c - - - - -
c      tlt3 t1 0      Table 6      Formula 2
c
c      t(50,3) = t(49,2) * p1q2 * q4(3) * q3(1,3,1) * q3(2,3,1)
c
c      p(3,2) = p(3,2) + t(50,3)
c - - - - -
c      t1 tlt3 0      Table 6      Formula 3
c
c      t(51,3) = t(49,2) * p2q1 * q4(3) * q3(1,3,1) * q3(2,3,1)
c
c      p(3,2) = p(3,2) + t(51,3)
c - - - - -
c      tlt3 tlt3 0      Table 6      Formula 4
c
c      t(52,3) = t(49,2) * p1p2 * q4(3) * q3(1,3,1) * q3(2,3,1)
c
c      p(3,2) = p(3,2) + t(52,3)
c - - - - -
c      tlt2 t1 0      Table 6      Formula 1

```

```

c      t(53,3) = t(53,2) * qlq2 * q4(3) * q3(1,3,3) * q3(2,3,1)
c
c      p(3,2) = p(3,2) + t(53,3)
c  -----
c      tlt2t3 t1 0      Table 6      Formula 2
c
c      t(54,3) = t(53,2) * plq2 * q4(3) * q3(1,3,3) * q3(2,3,1)
c
c      p(3,2) = p(3,2) + t(54,3)
c  -----
c      tlt2 tlt3 0      Table 6      Formula 3
c
c      t(55,3) = t(53,2) * p2q1 * q4(3) * q3(1,3,3) * q3(2,3,1)
c
c      p(3,2) = p(3,2) + t(55,3)
c  -----
c      tlt2t3 tlt3 0      Table 6      Formula 4
c
c      t(56,3) = t(53,2) * plp2 * q4(3) * q3(1,3,3) * q3(2,3,1)
c
c      p(3,2) = p(3,2) + t(56,3)
c  -----
c      t1 tlt2 0      Table 6      Formula 1
c
c      t(57,3) = t(57,2) * qlq2 * q4(3) * q3(1,3,1) * q3(2,3,3)
c
c      p(3,2) = p(3,2) + t(57,3)
c  -----
c      tlt3 tlt2 0      Table 6      Formula 2
c
c      t(58,3) = t(57,2) * plq2 * q4(3) * q3(1,3,1) * q3(2,3,3)
c
c      p(3,2) = p(3,2) + t(58,3)
c  -----
c      t1 tlt2t3 0      Table 6      Formula 3
c
c      t(59,3) = t(57,2) * p2q1 * q4(3) * q3(1,3,1) * q3(2,3,3)
c
c      p(3,2) = p(3,2) + t(59,3)
c  -----
c      tlt3 tlt2t3 0      Table 6      Formula 4
c
c      t(60,3) = t(57,2) * plp2 * q4(3) * q3(1,3,1) * q3(2,3,3)
c
c      p(3,2) = p(3,2) + t(60,3)
c  -----
c      tlt2 tlt2 0      Table 6      Formula 1
c
c      t(61,3) = t(61,2) * qlq2 * q4(3) * q3(1,3,3) * q3(2,3,3)
c
c      p(3,2) = p(3,2) + t(61,3)
c  -----
c      tlt2t3 tlt2 0      Table 6      Formula 2
c

```

```

c      t(62,3) = t(61,2) * plq2 * q4(3) * q3(1,3,3) * q3(2,3,3)
c
c      p(3,2) = p(3,2) + t(62,3)
c - - - - -
c      tlt2 tlt2t3 0      Table 6      Formula 3
c
c      t(63,3) = t(61,2) * p2q1 * q4(3) * q3(1,3,3) * q3(2,3,3)
c
c      p(3,2) = p(3,2) + t(63,3)
c - - - - -
c      tlt2t3 tlt2t3 0      Table 6      Formula 4
c
c      t(64,3) = t(61,2) * plp2 * q4(3) * q3(1,3,3) * q3(2,3,3)
c
c      p(3,2) = p(3,2) + t(64,3)
c - - - - -
c      * 0      Table 6      Formula 5
c
c      t(65,3) = q4(3) * ( t(65,2)
*          + t(1,2) * ( 1. - q5q6 )
*          + t(5,2) * ( 1. - q5q6 * q3(1,3,2) )
*          + t(9,2) * ( 1. - q5q6 * q3(2,3,2) )
*          + t(13,2) * ( 1. - q5q6 * q3(1,3,2) * q3(2,3,2) )
*          + t(17,2) * ( 1. - q5q6 * q3(1,3,1) )
*          + t(21,2) * ( 1. - q5q6 * q3(1,3,3) )
*          + t(25,2) * ( 1. - q5q6 * q3(1,3,1) * q3(2,3,2) )
*          + t(29,2) * ( 1. - q5q6 * q3(1,3,3) * q3(2,3,2) )
*          + t(33,2) * ( 1. - q5q6 * q3(2,3,1) )
*          + t(37,2) * ( 1. - q5q6 * q3(1,3,2) * q3(2,3,1) )
*          + t(41,2) * ( 1. - q5q6 * q3(2,3,3) )
*          + t(45,2) * ( 1. - q5q6 * q3(1,3,2) * q3(2,3,3) )
*          + t(49,2) * ( 1. - q5q6 * q3(1,3,1) * q3(2,3,1) )
*          + t(53,2) * ( 1. - q5q6 * q3(1,3,3) * q3(2,3,1) )
*          + t(57,2) * ( 1. - q5q6 * q3(1,3,1) * q3(2,3,3) )
*          + t(61,2) * ( 1. - q5q6 * q3(1,3,3) * q3(2,3,3) ) )
c
c      p(3,4) = p(3,4) + t(65,3)
c      p(3,8) = p(3,8) + t(65,3)
c      p(3,9) = p(3,9) + t(65,3)
c - - - - -
c      phi phi 1      Table 6      Formula 6
c
c      t(1,6) = qlq2 * ( t(1,2) * p4(3) + t(1,5) )
c
c      p(3,3) = p(3,3) + t(1,6)
c      p(3,7) = p(3,7) + t(1,6)
c      p(3,9) = p(3,9) + t(1,6)
c - - - - -
c      t3 phi 1      Table 6      Formula 7
c
c      t(2,6) = plq2 * ( t(1,2) * p4(3) + t(1,5) )
c
c      p(3,5) = p(3,5) + t(2,6)
c      p(3,7) = p(3,7) + t(2,6)
c      p(3,9) = p(3,9) + t(2,6)

```

```

c - - - - -
c   phi  t3  i           Table 6      Formula 8
c
c   t(3,6) = p2q1 * ( t(1,2) * p4(3) + t(1,5) )
c
c           p(3,5) = p(3,5) + t(3,6)
c           p(3,7) = p(3,7) + t(3,6)
c           p(3,9) = p(3,9) + t(3,6)
c - - - - -
c   t3  t3  l           Table 6      Formula 9
c
c   t(4,6) = plp2 * ( t(1,2) * p4(3) + t(1,5) )
c
c           p(3,5) = p(3,5) + t(4,6)
c           p(3,7) = p(3,7) + t(4,6)
c           p(3,9) = p(3,9) + t(4,6)
c - - - - -
c   t2  pni  l           Table 6      Formula o
c
c   t(5,6) = q1q2 * q3(1,3,2) * ( t(5,2) * p4(3) + t(5,5) )
c
c           p(3,5) = p(3,5) + t(5,6)
c           p(3,7) = p(3,7) + t(5,6)
c           p(3,9) = p(3,9) + t(5,6)
c - - - - -
c   t2t3  pni  l           Table 6      Formula 7
c
c   t(6,6) = plq2 * q3(1,3,2) * ( t(5,2) * p4(3) + t(5,5) )
c
c           p(3,5) = p(3,5) + t(6,6)
c           p(3,7) = p(3,7) + t(6,6)
c           p(3,9) = p(3,9) + t(6,6)
c - - - - -
c   t2  t3  l           Table 6      Formula 8
c
c   t(7,6) = p2q1 * q3(1,3,2) * ( t(5,2) * p4(3) + t(5,5) )
c
c           p(3,5) = p(3,5) + t(7,6)
c           p(3,7) = p(3,7) + t(7,6)
c           p(3,9) = p(3,9) + t(7,6)
c - - - - -
c   t2t3  t3  l           Table 6      Formula 9
c
c   t(8,6) = plp2 * q3(1,3,2) * ( t(5,2) * p4(3) + t(5,5) )
c
c           p(3,5) = p(3,5) + t(8,6)
c           p(3,7) = p(3,7) + t(8,6)
c           p(3,9) = p(3,9) + t(8,6)
c - - - - -
c   pni  t2  l           Table 6      Formula o
c
c   t(9,6) = q1q2 * q3(2,3,2) * ( t(9,2) * p4(3) + t(9,5) )
c
c           p(3,5) = p(3,5) + t(9,6)
c           p(3,7) = p(3,7) + t(9,6)

```

```

c -----
c      t3  t2  1      Table 6      Formula 7
c
c      t(10,6) = plq2 * q3(2,3,2) * ( t(9,2) * p4(3) + t(9,5) )
c
c      p(3,5) = p(3,5) + t(10,6)
c      p(3,7) = p(3,7) + t(10,6)
c      p(3,9) = p(3,9) + t(10,6)
c -----
c      phi  t2t3  1      Table 6      Formula 8
c
c      t(11,6) = p2q1 * q3(2,3,2) * ( t(9,2) * p4(3) + t(9,5) )
c
c      p(3,5) = p(3,5) + t(11,6)
c      p(3,7) = p(3,7) + t(11,6)
c      p(3,9) = p(3,9) + t(11,6)
c -----
c      t3  t2t3  1      Table 6      Formula 9
c
c      t(12,6) = plp2 * q3(2,3,2) * ( t(9,2) * p4(3) + t(9,5) )
c
c      p(3,5) = p(3,5) + t(12,6)
c      p(3,7) = p(3,7) + t(12,6)
c      p(3,9) = p(3,9) + t(12,6)
c -----
c      t2  t2  1      Table 6      Formula 6
c
c      t(13,6) = qlq2 * q3(1,3,2) * q3(2,3,2)
c      * ( t(13,2) * p4(3) + t(13,5) )
c
c      p(3,5) = p(3,5) + t(13,6)
c      p(3,7) = p(3,7) + t(13,6)
c      p(3,9) = p(3,9) + t(13,6)
c -----
c      t2t3  t2  1      Table 6      Formula 7
c
c      t(14,6) = plq2 * q3(1,3,2) * q3(2,3,2)
c      * ( t(13,2) * p4(3) + t(13,5) )
c
c      p(3,5) = p(3,5) + t(14,6)
c      p(3,7) = p(3,7) + t(14,6)
c      p(3,9) = p(3,9) + t(14,6)
c -----
c      t2  t2t3  1      Table 6      Formula 8
c
c      t(15,6) = p2q1 * q3(1,3,2) * q3(2,3,2)
c      * ( t(13,2) * p4(3) + t(13,5) )
c
c      p(3,5) = p(3,5) + t(15,6)
c      p(3,7) = p(3,7) + t(15,6)
c      p(3,9) = p(3,9) + t(15,6)
c -----
c      t2t3  t2t3  1      Table 6      Formula 9
c

```

```

      t(16,6) = plp2 * q3(1,3,2) * q3(2,3,2)
      *
      * ( t(13,2) * p4(3) + t(13,5) )
c
      p(3,5) = p(3,5) + t(16,6)
      p(3,7) = p(3,7) + t(16,6)
      p(3,9) = p(3,9) + t(16,6)
c -----
c      t1 phi 1          Table 6      Formula 6
c
      t(17,6) = qlq2 * q3(1,3,1)
      *
      * ( t(17,2) * p4(3) + t(17,5) )
c
      p(3,5) = p(3,5) + t(17,6)
      p(3,7) = p(3,7) + t(17,6)
      p(3,9) = p(3,9) + t(17,6)
c -----
c      t1t3 phi 1        Table 6      Formula 7
c
      t(18,6) = plq2 * q3(1,3,1)
      *
      * ( t(17,2) * p4(3) + t(17,5) )
c
      p(3,5) = p(3,5) + t(18,6)
      p(3,7) = p(3,7) + t(18,6)
      p(3,9) = p(3,9) + t(18,6)
c -----
c      t1 t3 1           Table 6      Formula 8
c
      t(19,6) = p2q1 * q3(1,3,1)
      *
      * ( t(17,2) * p4(3) + t(17,5) )
c
      p(3,5) = p(3,5) + t(19,6)
      p(3,7) = p(3,7) + t(19,6)
      p(3,9) = p(3,9) + t(19,6)
c -----
c      t1t3 t3 1         Table 6      Formula 9
c
      t(20,6) = plp2 * q3(1,3,1)
      *
      * ( t(17,2) * p4(3) + t(17,5) )
c
      p(3,5) = p(3,5) + t(20,6)
      p(3,7) = p(3,7) + t(20,6)
      p(3,9) = p(3,9) + t(20,6)
c -----
c      t1t2 phi 1        Table 6      Formula 6
c
      t(21,6) = qlq2 * q3(1,3,3)
      *
      * ( t(21,2) * p4(3) + t(21,5) )
c
      p(3,5) = p(3,5) + t(21,6)
      p(3,7) = p(3,7) + t(21,6)
      p(3,9) = p(3,9) + t(21,6)
c -----
c      t1t2t3 phi 1      Table 6      Formula 7
c
      t(22,6) = plq2 * q3(1,3,3)

```

```

*
c          * ( t(21,2) * p4(3) + t(21,5) )
c
c          p(3,5) = p(3,5) + t(22,6)
c          p(3,7) = p(3,7) + t(22,6)
c          p(3,9) = p(3,9) + t(22,6)
c -----
c      t1t2 t3 1          Table 6      Formula 8
c
c      t(23,6) = p2q1 * q3(1,3,3)
c
c          * ( t(21,2) * p4(3) + t(21,5) )
c
c          p(3,5) = p(3,5) + t(23,6)
c          p(3,7) = p(3,7) + t(23,6)
c          p(3,9) = p(3,9) + t(23,6)
c -----
c      t1t2t3 t3 1          Table 6      Formula 9
c
c      t(24,6) = p1p2 * q3(1,3,3)
c
c          * ( t(21,2) * p4(3) + t(21,5) )
c
c          p(3,5) = p(3,5) + t(24,6)
c          p(3,7) = p(3,7) + t(24,6)
c          p(3,9) = p(3,9) + t(24,6)
c -----
c      t1 t2 1          Table 6      Formula 6
c
c      t(25,6) = q1q2 * q3(1,3,1) * q3(2,3,2)
c
c          * ( t(25,2) * p4(3) + t(25,5) )
c
c          p(3,5) = p(3,5) + t(25,6)
c          p(3,7) = p(3,7) + t(25,6)
c          p(3,9) = p(3,9) + t(25,6)
c -----
c      t1t3 t2 1          Table 6      Formula 7
c
c      t(26,6) = p1q2 * q3(1,3,1) * q3(2,3,2)
c
c          * ( t(25,2) * p4(3) + t(25,5) )
c
c          p(3,5) = p(3,5) + t(26,6)
c          p(3,7) = p(3,7) + t(26,6)
c          p(3,9) = p(3,9) + t(26,6)
c -----
c      t1 t2t3 1          Table 6      Formula 8
c
c      t(27,6) = p2q1 * q3(1,3,1) * q3(2,3,2)
c
c          * ( t(25,2) * p4(3) + t(25,5) )
c
c          p(3,5) = p(3,5) + t(27,6)
c          p(3,7) = p(3,7) + t(27,6)
c          p(3,9) = p(3,9) + t(27,6)
c -----
c      t1t3 t2t3 1          Table 6      Formula 9
c
c      t(28,6) = p1p2 * q3(1,3,1) * q3(2,3,2)
c
c          * ( t(25,2) * p4(3) + t(25,5) )

```

c

$$\begin{aligned} p(3,5) &= p(3,5) + \tau(28,6) \\ p(3,7) &= p(3,7) + \tau(28,6) \\ p(3,9) &= p(3,9) + \tau(28,6) \end{aligned}$$

c -----

c $\tau_1 \tau_2$ τ_2 i Table 6 Formula 6

c

$$\begin{aligned} \tau(29,6) &= q_1 q_2 * q_3(1,3,3) * q_3(2,3,2) \\ * &\quad * (\tau(29,2) * p_4(3) + \tau(29,5)) \end{aligned}$$

c

$$\begin{aligned} p(3,5) &= p(3,5) + \tau(29,6) \\ p(3,7) &= p(3,7) + \tau(29,6) \\ p(3,9) &= p(3,9) + \tau(29,6) \end{aligned}$$

c -----

c $\tau_1 \tau_2 \tau_3$ τ_2 1 Table 6 Formula 7

c

$$\begin{aligned} \tau(30,6) &= p_1 q_2 * q_3(1,3,3) * q_3(2,3,2) \\ * &\quad * (\tau(29,2) * p_4(3) + \tau(29,5)) \end{aligned}$$

c

$$\begin{aligned} p(3,5) &= p(3,5) + \tau(30,6) \\ p(3,7) &= p(3,7) + \tau(30,6) \\ p(3,9) &= p(3,9) + \tau(30,6) \end{aligned}$$

c -----

c $\tau_1 \tau_2$ $\tau_2 \tau_3$ 1 Table 6 Formula 8

c

$$\begin{aligned} \tau(31,6) &= p_2 q_1 * q_3(1,3,3) * q_3(2,3,2) \\ * &\quad * (\tau(29,2) * p_4(3) + \tau(29,5)) \end{aligned}$$

c

$$\begin{aligned} p(3,5) &= p(3,5) + \tau(31,6) \\ p(3,7) &= p(3,7) + \tau(31,6) \\ p(3,9) &= p(3,9) + \tau(31,6) \end{aligned}$$

c -----

c $\tau_1 \tau_2 \tau_3$ $\tau_2 \tau_3$ 1 Table 6 Formula 9

c

$$\begin{aligned} \tau(32,6) &= p_1 p_2 * q_3(1,3,3) * q_3(2,3,2) \\ * &\quad * (\tau(29,2) * p_4(3) + \tau(29,5)) \end{aligned}$$

c

$$\begin{aligned} p(3,5) &= p(3,5) + \tau(32,6) \\ p(3,7) &= p(3,7) + \tau(32,6) \\ p(3,9) &= p(3,9) + \tau(32,6) \end{aligned}$$

c -----

c ϕ_i τ_1 1 Table 6 Formula 6

c

$$\begin{aligned} \tau(33,6) &= q_1 q_2 * q_3(2,3,1) \\ * &\quad * (\tau(33,2) * p_4(3) + \tau(33,5)) \end{aligned}$$

c

$$\begin{aligned} p(3,5) &= p(3,5) + \tau(33,6) \\ p(3,7) &= p(3,7) + \tau(33,6) \\ p(3,9) &= p(3,9) + \tau(33,6) \end{aligned}$$

c -----

c τ_3 τ_1 1 Table 6 Formula 7

c

$$\begin{aligned} \tau(34,6) &= p_1 q_2 * q_3(2,3,1) \\ * &\quad * (\tau(33,2) * p_4(3) + \tau(33,5)) \end{aligned}$$

c

$$\begin{aligned} p(3,5) &= p(3,5) + t(34,6) \\ p(3,7) &= p(3,7) + t(34,6) \\ p(3,9) &= p(3,9) + t(34,6) \end{aligned}$$

c -----
c phi tlt3 1 Table 6 Formula 8
c

$$\begin{aligned} t(35,6) &= p2q1 * q3(2,3,1) \\ &* (t(33,2) * p4(3) + t(33,5)) \end{aligned}$$

$$\begin{aligned} p(3,5) &= p(3,5) + t(35,6) \\ p(3,7) &= p(3,7) + t(35,6) \\ p(3,9) &= p(3,9) + t(35,6) \end{aligned}$$

c -----
c t3 tlt3 1 Table 6 Formula 9
c

$$\begin{aligned} t(36,6) &= p1p2 * q3(2,3,1) \\ &* (t(33,2) * p4(3) + t(33,5)) \end{aligned}$$

$$\begin{aligned} p(3,5) &= p(3,5) + t(36,6) \\ p(3,7) &= p(3,7) + t(36,6) \\ p(3,9) &= p(3,9) + t(36,6) \end{aligned}$$

c -----
c t2 t1 1 Table 6 Formula 6
c

$$\begin{aligned} t(37,6) &= q1q2 * q3(1,3,2) * q3(2,3,1) \\ &* (t(37,2) * p4(3) + t(37,5)) \end{aligned}$$

$$\begin{aligned} p(3,5) &= p(3,5) + t(37,6) \\ p(3,7) &= p(3,7) + t(37,6) \\ p(3,9) &= p(3,9) + t(37,6) \end{aligned}$$

c -----
c t2t3 t1 1 Table 6 Formula 7
c

$$\begin{aligned} t(38,6) &= p1q2 * q3(1,3,2) * q3(2,3,1) \\ &* (t(37,2) * p4(3) + t(37,5)) \end{aligned}$$

$$\begin{aligned} p(3,5) &= p(3,5) + t(38,6) \\ p(3,7) &= p(3,7) + t(38,6) \\ p(3,9) &= p(3,9) + t(38,6) \end{aligned}$$

c -----
c t2 tlt3 1 Table 6 Formula 8
c

$$\begin{aligned} t(39,6) &= p2q1 * q3(1,3,2) * q3(2,3,1) \\ &* (t(37,2) * p4(3) + t(37,5)) \end{aligned}$$

$$\begin{aligned} p(3,5) &= p(3,5) + t(39,6) \\ p(3,7) &= p(3,7) + t(39,6) \\ p(3,9) &= p(3,9) + t(39,6) \end{aligned}$$

c -----
c t2t3 tlt3 1 Table 6 Formula 9
c

$$\begin{aligned} t(40,6) &= p1p2 * q3(1,3,2) * q3(2,3,1) \\ &* (t(37,2) * p4(3) + t(37,5)) \end{aligned}$$

$$p(3,5) = p(3,5) + t(40,6)$$

```

p(3,7) = p(3,7) + t(40,6)
p(3,9) = p(3,9) + t(40,6)
c - - - - -
c   phi  tlt2  1      Table 6      Formula 6
c
c   t(41,6) = qlq2 * q3(2,3,3)
*                               * ( t(41,2) * p4(3) + t(41,5) )
c
c   p(3,5) = p(3,5) + t(41,6)
c   p(3,7) = p(3,7) + t(41,6)
c   p(3,9) = p(3,9) + t(41,6)
c - - - - -
c   t3  tlt2  1      Table 6      Formula 7
c
c   t(42,6) = plq2 * q3(2,3,3)
*                               * ( t(41,2) * p4(3) + t(41,5) )
c
c   p(3,5) = p(3,5) + t(42,6)
c   p(3,7) = p(3,7) + t(42,6)
c   p(3,9) = p(3,9) + t(42,6)
c - - - - -
c   phi  tlt2t3  1      Table 6      Formula 8
c
c   t(43,6) = p2q1 * q3(2,3,3)
*                               * ( t(41,2) * p4(3) + t(41,5) )
c
c   p(3,5) = p(3,5) + t(43,6)
c   p(3,7) = p(3,7) + t(43,6)
c   p(3,9) = p(3,9) + t(43,6)
c - - - - -
c   t3  tlt2t3  1      Table 6      Formula 9
c
c   t(44,6) = pip2 * q3(2,3,3)
*                               * ( t(41,2) * p4(3) + t(41,5) )
c
c   p(3,5) = p(3,5) + t(44,6)
c   p(3,7) = p(3,7) + t(44,6)
c   p(3,9) = p(3,9) + t(44,6)
c - - - - -
c   t2  tlt2  1      Table 6      Formula 6
c
c   t(45,6) = qlq2 * q3(1,3,2) * q3(2,3,3)
*                               * ( t(45,2) * p4(3) + t(45,5) )
c
c   p(3,5) = p(3,5) + t(45,6)
c   p(3,7) = p(3,7) + t(45,6)
c   p(3,9) = p(3,9) + t(45,6)
c - - - - -
c   t2t3  tlt2  1      Table 6      Formula 7
c
c   t(46,6) = plq2 * q3(1,3,2) * q3(2,3,3)
*                               * ( t(45,2) * p4(3) + t(45,5) )
c
c   p(3,5) = p(3,5) + t(46,6)
c   p(3,7) = p(3,7) + t(46,6)

```

```

c -----
c      p(3,9) = p(3,9) + t(46,6)
c      t2  t1t2t3  1      Table 6      Formula 8
c
c      t(47,6) = p2q1 * q3(1,3,2) * q3(2,3,3)
c      *      * ( t(45,2) * p4(3) + t(45,5) )
c
c      p(3,5) = p(3,5) + t(47,6)
c      p(3,7) = p(3,7) + t(47,6)
c      p(3,9) = p(3,9) + t(47,6)
c -----
c      t2t3  t1t2t3  1      Table 6      Formula 9
c
c      t(48,6) = plp2 * q3(1,3,2) * q3(2,3,3)
c      *      * ( t(45,2) * p4(3) + t(45,5) )
c
c      p(3,5) = p(3,5) + t(48,6)
c      p(3,7) = p(3,7) + t(48,6)
c      p(3,9) = p(3,9) + t(48,6)
c -----
c      t1  t1  1      Table 6      Formula 6
c
c      t(49,6) = qlq2 * q3(1,3,1) * q3(2,3,1)
c      *      * ( t(49,2) * p4(3) + t(49,5) )
c
c      p(3,5) = p(3,5) + t(49,6)
c      p(3,7) = p(3,7) + t(49,6)
c      p(3,9) = p(3,9) + t(49,6)
c -----
c      t1t3  t1  1      Table 6      Formula 7
c
c      t(50,6) = plq2 * q3(1,3,1) * q3(2,3,1)
c      *      * ( t(49,2) * p4(3) + t(49,5) )
c
c      p(3,5) = p(3,5) + t(50,6)
c      p(3,7) = p(3,7) + t(50,6)
c      p(3,9) = p(3,9) + t(50,6)
c -----
c      t1  t1t3  1      Table 6      Formula 8
c
c      t(51,6) = p2q1 * q3(1,3,1) * q3(2,3,1)
c      *      * ( t(49,2) * p4(3) + t(49,5) )
c
c      p(3,5) = p(3,5) + t(51,6)
c      p(3,7) = p(3,7) + t(51,6)
c      p(3,9) = p(3,9) + t(51,6)
c -----
c      t1t3  t1t3  1      Table 6      Formula 9
c
c      t(52,6) = plp2 * q3(1,3,1) * q3(2,3,1)
c      *      * ( t(49,2) * p4(3) + t(49,5) )
c
c      p(3,5) = p(3,5) + t(52,6)
c      p(3,7) = p(3,7) + t(52,6)
c      p(3,9) = p(3,9) + t(52,6)

```

```

c -----
c      tlt2  t1  1      Table 6      Formula 6
c
c      t(53,6) = q1q2 * q3(1,3,3) * q3(2,3,1)
c      *      * ( t(53,2) * p4(3) + t(53,5) )
c
c      p(3,5) = p(3,5) + t(53,6)
c      p(3,7) = p(3,7) + t(53,6)
c      p(3,9) = p(3,9) + t(53,6)
c -----
c      tlt2t3  t1  1      Table 6      Formula 7
c
c      t(54,6) = p1q2 * q3(1,3,3) * q3(2,3,1)
c      *      * ( t(53,2) * p4(3) + t(53,5) )
c
c      p(3,5) = p(3,5) + t(54,6)
c      p(3,7) = p(3,7) + t(54,6)
c      p(3,9) = p(3,9) + t(54,6)
c -----
c      tlt2  tlt3  1      Table 6      Formula 8
c
c      t(55,6) = p2q1 * q3(1,3,3) * q3(2,3,1)
c      *      * ( t(53,2) * p4(3) + t(53,5) )
c
c      p(3,5) = p(3,5) + t(55,6)
c      p(3,7) = p(3,7) + t(55,6)
c      p(3,9) = p(3,9) + t(55,6)
c -----
c      tlt2t3  tlt3  1      Table 6      Formula 9
c
c      t(56,6) = p1p2 * q3(1,3,3) * q3(2,3,1)
c      *      * ( t(53,2) * p4(3) + t(53,5) )
c
c      p(3,5) = p(3,5) + t(56,6)
c      p(3,7) = p(3,7) + t(56,6)
c      p(3,9) = p(3,9) + t(56,6)
c -----
c      t1  tlt2  1      Table 6      Formula 6
c
c      t(57,6) = q1q2 * q3(1,3,1) * q3(2,3,3)
c      *      * ( t(57,2) * p4(3) + t(57,5) )
c
c      p(3,5) = p(3,5) + t(57,6)
c      p(3,7) = p(3,7) + t(57,6)
c      p(3,9) = p(3,9) + t(57,6)
c -----
c      tlt3  tlt2  1      Table 6      Formula 7
c
c      t(58,6) = p1q2 * q3(1,3,1) * q3(2,3,3)
c      *      * ( t(57,2) * p4(3) + t(57,5) )
c
c      p(3,5) = p(3,5) + t(58,6)
c      p(3,7) = p(3,7) + t(58,6)
c      p(3,9) = p(3,9) + t(58,6)
c -----

```

c t1 t1t2t3 1 Table 6 Formula 8

c

$$t(59,6) = p2q1 * q3(1,3,1) * q3(2,3,3) \\ * (t(57,2) * p4(3) + t(57,5))$$

c

$$p(3,5) = p(3,5) + t(59,6) \\ p(3,7) = p(3,7) + t(59,6) \\ p(3,9) = p(3,9) + t(59,6)$$

c

c t1t3 t1t2t3 1 Table 6 Formula 9

c

$$t(60,6) = plp2 * q3(1,3,1) * q3(2,3,3) \\ * (t(57,2) * p4(3) + t(57,5))$$

c

$$p(3,5) = p(3,5) + t(60,6) \\ p(3,7) = p(3,7) + t(60,6) \\ p(3,9) = p(3,9) + t(60,6)$$

c

c t1t2 t1t2 1 Table 6 Formula 6

c

$$t(61,6) = qlq2 * q3(1,3,3) * q3(2,3,3) \\ * (t(61,2) * p4(3) + t(61,5))$$

c

$$p(3,5) = p(3,5) + t(61,6) \\ p(3,7) = p(3,7) + t(61,6) \\ p(3,9) = p(3,9) + t(61,6)$$

c

c t1t2t3 t1t2 1 Table 6 Formula 7

c

$$t(62,6) = plq2 * q3(1,3,3) * q3(2,3,3) \\ * (t(61,2) * p4(3) + t(61,5))$$

c

$$p(3,5) = p(3,5) + t(62,6) \\ p(3,7) = p(3,7) + t(62,6) \\ p(3,9) = p(3,9) + t(62,6)$$

c

c t1t2 t1t2t3 1 Table 6 Formula 8

c

$$t(63,6) = p2q1 * q3(1,3,3) * q3(2,3,3) \\ * (t(61,2) * p4(3) + t(61,5))$$

c

$$p(3,5) = p(3,5) + t(63,6) \\ p(3,7) = p(3,7) + t(63,6) \\ p(3,9) = p(3,9) + t(63,6)$$

c

c t1t2t3 t1t2t3 1 Table 6 Formula 9

c

$$t(64,6) = plp2 * q3(1,3,3) * q3(2,3,3) \\ * (t(61,2) * p4(3) + t(61,5))$$

c

$$p(3,5) = p(3,5) + t(64,6) \\ p(3,7) = p(3,7) + t(64,6) \\ p(3,9) = p(3,9) + t(64,6)$$

c

c * 1 Table 6 Formula 10

c

```

t(65,6) = t(65,2) * p4(3) + t(65,5)
* + ( t(1,2) * p4(3) + t(1,5) ) * ( 1. - q5q6 )
* + ( t(5,2) * p4(3) + t(5,5) ) * ( 1. - q5q6 * q3(1,3,2) )
* + ( t(9,2) * p4(3) + t(9,5) ) * ( 1. - q5q6 * q3(2,3,2) )
* + ( t(13,2) * p4(3) + t(13,5) )
* * ( 1. - q5q6 * q3(1,3,2) * q3(2,3,2) )
* + ( t(17,2) * p4(3) + t(17,5) ) * ( 1. - q5q6 * q3(1,3,1) )
* + ( t(21,2) * p4(3) + t(21,5) ) * ( 1. - q5q6 * q3(1,3,3) )
* + ( t(25,2) * p4(3) + t(25,5) )
* * ( 1. - q5q6 * q3(1,3,1) * q3(2,3,2) )
* + ( t(29,2) * p4(3) + t(29,5) )
* * ( 1. - q5q6 * q3(1,3,3) * q3(2,3,2) )
* + ( t(33,2) * p4(3) + t(33,5) ) * ( 1. - q5q6 * q3(2,3,1) )
t(65,6) = t(65,6) + ( t(37,2) * p4(3) + t(37,5) )
* * ( 1. - q5q6 * q3(1,3,2) * q3(2,3,1) )
* + ( t(41,2) * p4(3) + t(41,5) ) * ( 1. - q5q6 * q3(2,3,3) )
* + ( t(45,2) * p4(3) + t(45,5) )
* * ( 1. - q5q6 * q3(1,3,2) * q3(2,3,3) )
* + ( t(49,2) * p4(3) + t(49,5) )
* * ( 1. - q5q6 * q3(1,3,1) * q3(2,3,1) )
* + ( t(53,2) * p4(3) + t(53,5) )
* * ( 1. - q5q6 * q3(1,3,3) * q3(2,3,1) )
* + ( t(57,2) * p4(3) + t(57,5) )
* * ( 1. - q5q6 * q3(1,3,1) * q3(2,3,3) )
* + ( t(61,2) * p4(3) + t(61,5) )
* * ( 1. - q5q6 * q3(1,3,3) * q3(2,3,3) )

```

c

```

p(3,6) = p(3,6) + t(65,6)
p(3,7) = p(3,7) + t(65,6)
p(3,8) = p(3,8) + t(65,6)
p(3,9) = p(3,9) + t(65,6)

```

c

```

-----
ptot = p(3,1) + p(3,2) + p(3,3) + p(3,4) + p(3,5) + p(3,6)
if( abs( 1. - ptot ) .gt. .000001 )write (*,100) ptot
100 format(' sum of INDEPENDENT probabilities for 3 bursts is ',f10.7)
return
end

```

The next page is blank.

DISTRIBUTION LIST

<u>No. of Copies</u>	<u>Organization</u>	<u>No. of Copies</u>	<u>Organization</u>
12	Commander Defense Technical Information Center ATTN: DTIC-DDAC Cameron Station, Bldg 5 Alexandria, VA 22134-6145	1	Commander US Army Natick R&D Center ATTN: STRNC-O Natick, MA 01760-5015
7	Commander US Army Materiel Command ATTN: AMCRM AMCDMA-M AMCMI AMCDE AMCDE-Q AMCQA AMCLD (Dr. Odom) 5001 Eisenhower Avenue Alexandria, VA 22333-0001	2	Director US Army TRADOC Systems Analysis Activity ATTN: ATOR-TSL ATOR-T White Sands Missile Range, NM 88002-5502
2	Commander Armament Research & Development Center Attn: SMCR-TSS Dover, NJ 07801-5001	1	Commander US Army Missile Command ATTN: AMSMI-DS Redstone Arsenal, AL 35898-5060
1	Commander HQ AMCCOM ATTN: SMCAR-ESP-L Rock Island, IL 61299-7300	1	Commander US Army Tank-Automotive Command ATTN: AMSTA-RGRD (Mr. Graham) AMSTA-RSS (Dr. Thompson) Warren, MI 48090
1	Commander US Army Aviation Systems Command Directorate for Plans & Analysis ATTN: AMSAV-BC 4300 Goodfellow Blvd St. Louis, MO 63120-1798	1	Commander US Army Tank-Automotive Command ATTN: AMSTA-TSL Warren, MI 48397-5000
1	Commander US Army Concepts Analysis Agency ATTN: CSCA-MSI-L 8120 Woodmont Avenue Bethesda, MD 20814-2797	1	Pentagon Library ATTN: ANR-AL-RS (Army Studies) Pentagon, Rm 1A518 Washington, DC 20310
1	Commandant US Army Infantry School ATTN: ATSH-CD-CS-OR Fort Benning, GA 31905-5400	3	Chief Defense Logistics Studies Information Exchange US Army Logistics Management Center ATTN: AMXCM-D (2 cys) AMXCM-ACM (Mr. Fowler) Fort Lee, VA 23801-6043
		1	Commander USAREUR & 7th Army ATTN: AEAG-X-OR APO New York 09403

DISTRIBUTION LIST (continued)

<u>No. of Copies</u>	<u>Organization</u>	<u>No. of Copies</u>	<u>Organization</u>
2	Commander US Army Development and Employment Agency ATTN: MODE-TED-SAB Ft. Lewis, WA 98433-5000	1	Director Combat Data Information Center AFWAL/FIES/CDIC Wright-Patterson AFB, OH 45433-5000
1	Commander US Army Laboratory Command ATTN: AMSLC-TD (Mr. Vitali) Adelphi, MD 20783-1145	2	Commandant US Army Quartermaster School ATTN: ASTM-CDM (MSG Carstins) (LTC Settle) Fort Lee, VA 23801
3	Belvoir Fuels and Lubricants Research Facility Southwest Research Institute ATTN: Mr. Sidney Lestz Mr. Bernard Wright Dr. Mike Kanakia Postal Drawer 28510 San Antonio, TX 78284	2	Commander US Army Belvoir Research, Development, and Engineering Center ATTN: STRBE-VF (Mr. LePera) (Mr. Schaekel) Fort Belvoir, VA 22060-5606

Aberdeen Proving Ground

3	Cdr, USATECOM ATTN: AMSTE-AD AMSTE-TO-F AMSTE-CT-T (Mr. Ritondo) Bldg 314 APG, MD 21005-5055	8	Dir, BRL ATTN: SLCBR-VL-V (J. Ploskonka) (P. Dietz) SLCBR-VL-S (G. Holloway) SLCBR-VL-G (D. Kirk) SLCBR-OD-ST SLCBR-OD SLCBR-TB-A (J. Dehn) SLCBR-TB-E (A. Finnerty) Bldg 328 APG, MD 21005-5066
1	Dir, HEL ATTN: AMXHE-FS (Dr. Hofmann) Bldg 459 APG, MD 21005-5001		